



Complete Summary

GUIDELINE TITLE

ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to revise the 1999 guidelines for the Management of Acute Myocardial Infarction).

BIBLIOGRAPHIC SOURCE(S)

Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, Hochman JS, Krumholz HM, Kushner FG, Lamas GA, Mullany CJ, Ornato JP, Pearle DL, Sloan MA, Smith SC Jr. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction. A report of the Am Coll of Cardiol/Am Heart Assoc Task Force on Practice Guidelines (Committee to revise the 1999 guidelines). Bethesda (MD): American College of Cardiology, American Heart Association; 2004. 211 p. [1398 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Ryan TJ, Antman EM, Brooks NH, Califf RM, Hillis LD, Hiratzka LF, Rapaport E, Riegel B, Russell RO, Smith EE III, Weaver WD. 1999 update: ACC/AHA guidelines for the management of patients with acute myocardial infarction. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 1999 Sep; 34(3): 890-911.

** REGULATORY ALERT **

FDA WARNING/REGULATORY ALERT

Note from the National Guideline Clearinghouse: This guideline references a drug(s) for which important revised regulatory information has been released.

On April 7, 2005, after concluding that the overall risk versus benefit profile is unfavorable, the FDA requested that Pfizer, Inc voluntarily withdraw Bextra (valdecoxib) from the market. The FDA also asked manufacturers of all marketed prescription nonsteroidal anti-inflammatory drugs (NSAIDs), including Celebrex (celecoxib), a COX-2 selective NSAID, to revise the labeling (package insert) for their products to include a boxed warning and a Medication Guide. Finally, FDA asked manufacturers of non-prescription (over the counter [OTC]) NSAIDs to revise their labeling to include more specific information about the potential gastrointestinal (GI) and cardiovascular (CV) risks, and information to assist

consumers in the safe use of the drug. See the [FDA Web site](#) for more information.

Subsequently, on June 15, 2005, the FDA requested that sponsors of all non-steroidal anti-inflammatory drugs (NSAID) make labeling changes to their products. FDA recommended proposed labeling for both the prescription and over-the-counter (OTC) NSAIDs and a medication guide for the entire class of prescription products. All sponsors of marketed prescription NSAIDs, including Celebrex (celecoxib), a COX-2 selective NSAID, have been asked to revise the labeling (package insert) for their products to include a boxed warning, highlighting the potential for increased risk of cardiovascular (CV) events and the well described, serious, potential life-threatening gastrointestinal (GI) bleeding associated with their use. FDA regulation 21CFR 208 requires a Medication Guide to be provided with each prescription that is dispensed for products that FDA determines pose a serious and significant public health concern. See the [FDA Web site](#) for more information.

COMPLETE SUMMARY CONTENT

** REGULATORY ALERT **

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INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT

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SCOPE

DISEASE/CONDITION(S)

ST-elevation myocardial infarction (STEMI)

GUIDELINE CATEGORY

Diagnosis

Evaluation

Treatment

CLINICAL SPECIALTY

Cardiology

Critical Care

Emergency Medicine

Family Practice

Internal Medicine

INTENDED USERS

Health Care Providers
Physicians

GUIDELINE OBJECTIVE(S)

- To assist physicians and other healthcare providers in clinical decision making by describing a range of generally accepted approaches for the diagnosis, management, and prevention of ST-elevation myocardial infarction (STEMI)
- To focus on the numerous advances in the diagnosis and management of patients with ST-elevation myocardial infarction (STEMI) since 1999

TARGET POPULATION

- Adults with ST-elevation myocardial infarction (STEMI)
- Adults at risk of ST-elevation myocardial infarction

INTERVENTIONS AND PRACTICES CONSIDERED

Management before ST-elevation Myocardial Infarction (STEMI)

1. Identification of patients at risk of STEMI
2. Patient education for early recognition and response to STEMI

Management after Onset of STEMI

1. Management of out-of-hospital cardiac arrest
 - Activation of Emergency Medical System (EMS)
 - Early defibrillation
 - Early advanced cardiac life support
 - Cardiopulmonary resuscitation training program for families

Prehospital Issues

1. Training of emergency medical services systems personnel to respond to patients with chest pain and/or cardiac arrest
2. Prehospital chest pain evaluation and treatment
3. Prehospital fibrinolysis
4. Prehospital destination protocols

Initial Recognition and Management in the Emergency Department (ED)

1. Optimal strategies for ED triage
2. Initial patient evaluation
 - History
 - Physical examination
 - Electrocardiogram
 - Laboratory examinations
 - Measurement of biomarkers of cardiac damage
 - Imaging

3. Management

- Oxygen
- Nitroglycerin
- Analgesia
- Aspirin
- Beta-blockers
- Reperfusion (pharmacological reperfusion, percutaneous coronary intervention, acute surgical perfusion)
- Ancillary reperfusion therapy, including aspirin, clopidogrel, glycoprotein IIb/IIIa inhibitors
- Other pharmacological measures, including angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers, strict glucose control (e.g., insulin for people with diabetes), magnesium, calcium channel blockers (e.g., verapamil, diltiazem)

Hospital Management

1. Admission to coronary care unit
2. Admission to step-down unit
3. Early, general measures
 - Monitoring level of activity
 - Diet (e.g., National Cholesterol Education Program [NCEP] Adult Treatment Panel III Therapeutic Lifestyle Changes Diet)
 - Patient education in the hospital setting
 - Analgesia/anxiolytics
4. Risk stratification during early hospital course
5. Medication assessment
6. Estimation of infarct size
 - Electrocardiographic techniques
 - Cardiac biomarker methods
 - Radionuclide imaging
 - Echocardiography
 - Magnetic resonance imaging
7. Management of hemodynamic disturbances
 - Hemodynamic assessment
 - Management of hypotension (e.g., volume loading, vasopressors, intra-aortic balloon counterpulsation)
 - Management of low-output state (e.g., inotropic support, mechanical reperfusion, surgical correction of mechanical complications)
 - Management of pulmonary congestion (e.g., oxygen, morphine sulfate, angiotensin-converting enzyme [ACE] inhibitors, nitrates, diuretics, beta-blockers, aldosterone blockade, echocardiographic assessment, intra-aortic balloon pump)
 - Management of cardiogenic shock (e.g., intra-aortic balloon counterpulsation, early revascularization, fibrinolytic therapy, echocardiographic assessment)
 - Management of right ventricular infarction
 - Management of mechanical causes of heart failure/low-output syndrome (e.g., surgical repairs, intra-aortic balloon counterpulsation)
8. Management of arrhythmias after STEMI, including ventricular arrhythmias, supraventricular arrhythmias/atrial fibrillation, and bradyarrhythmias, atrioventricular, and intraventricular conduction disturbances

- Use of unsynchronized electric shock
 - Antiarrhythmic drugs
 - Use of synchronized electrical cardioversion
 - Implantable cardioverter defibrillator implantation
 - Use of permanent pacemakers
 - Use of prompt resuscitative measures (chest compressions, atropine, vasopressin, epinephrine, temporary pacing)
9. Management of recurrent chest pain after STEMI
 - Management of pericarditis (e.g., aspirin, anticoagulation, colchicine, acetaminophen, nonsteroidal anti-inflammatory drugs, corticosteroids)
 - Management of recurrent ischemia/infarction (escalation of medical therapy, cardiac catheterization and revascularization as needed, readministration of fibrinolytic therapy)
 10. Management of other complications, including ischemic stroke and embolisms (e.g., use of antithrombotic therapy, low-molecular weight heparins, warfarin)
 11. Coronary artery bypass graft surgery after STEMI
 12. Convalescence, discharge, and post-myocardial infarction care
 - Risk stratification
 - Exercise testing
 - Echocardiographic assessment
 - Exercise myocardial perfusion imaging
 - Assessment of left ventricular function (coronary arteriography, catheterization and revascularization)
 - Assessment of ventricular arrhythmias
 13. Secondary prevention
 - Patient education before discharge
 - Lipid management (lipid assessment, diet or drug therapy)
 - Weight management
 - Smoking cessation
 - Antiplatelet therapy
 - Inhibition of renin-angiotensin-aldosterone-system
 - Beta-blockers
 - Blood pressure control
 - Diabetes management
 - Hormone therapy (not recommended)
 - Warfarin therapy
 - Physical activity
 - Antioxidants (not recommended)

Long-Term Management

1. Evaluation of psychosocial impact of STEMI and treatment of psychological symptoms
2. Cardiac rehabilitation
3. Follow-up visit with medical provider

MAJOR OUTCOMES CONSIDERED

- Morbidity and mortality due to ST-elevation myocardial infarction (STEMI)
- Primary prevention of STEMI
- Secondary prevention of cardiovascular events, including second myocardial infarction, sudden cardiac death, recurrent myocardial ischemia, stroke

- Time to treatment
- Incidence of serious bleeding or stroke
- Ejection fraction

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Hand-searches of Published Literature (Primary Sources)
 Hand-searches of Published Literature (Secondary Sources)
 Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The guideline committee conducted comprehensive searching of the scientific and medical literature on acute myocardial infarction (AMI), with special emphasis on ST-elevation myocardial infarction (STEMI). Literature searching was limited to publications on humans and in English from 1990 to 2004. In addition to broad-based searching on MI, specific targeted searches were performed on MI and the following subtopics: 9-1-1, patient delays, emergency medical services (EMS), prehospital fibrinolysis, prehospital electrocardiogram (ECG), emergency department (ED), supplemental oxygen, nitroglycerin, aspirin (acetylsalicylic acid [ASA]), clopidogrel, arrhythmia, reperfusion, fibrinolysis/fibrinolytic therapy, angioplasty, stent, coronary artery bypass graft surgery (CABG), glycoprotein (GP) IIb/IIIa, pericarditis, beta-blockers, ischemia, intra-arterial pressure monitoring, angiotensin-converting enzyme (ACE) inhibitors, amiodarone, procainamide, lidocaine, electrical cardioversion, atropine, temporary pacing, transvenous pacing, permanent pacing, cardiac repair, heparin, low-molecular-weight heparin (LMWH), unfractionated heparin (UFH), ramipril, calcium channel blockers, verapamil, nifedipine, magnesium, stress ECG, invasive strategy, secondary prevention, statins, and cholesterol. The complete list of keywords is beyond the scope of this section. The committee reviewed all compiled reports from computerized searches and conducted additional searching by hand. Literature citations were generally restricted to published manuscripts appearing in journals listed in Index Medicus. Because of the scope and importance of certain ongoing clinical trials and other emerging information, published abstracts were cited when they were the only published information available.

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Levels of Evidence:

A: Data derived from multiple randomized clinical trials or meta-analyses

B: Data derived from a single randomized trial, or nonrandomized studies

C: Only consensus opinion of experts, case studies, or standard-of-care

METHODS USED TO ANALYZE THE EVIDENCE

Meta-Analysis of Randomized Controlled Trials

Systematic Review

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

Not stated

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Note from the National Guideline Clearinghouse (NGC): The first guideline published by the American College of Cardiology/American Heart Association (ACC/AHA) described the management of patients with acute myocardial infarction (AMI). The subsequent three documents were the Agency for Healthcare and Quality/National Heart, Lung and Blood Institute sponsored guideline on management of unstable angina (UA), the revised/updated ACC/AHA guideline on AMI, and the revised/updated ACC/AHA guideline on unstable angina/non–ST-segment myocardial infarction (UA/NSTEMI). The present guideline is a revision and deals strictly with the management of patients presenting with ST-elevation myocardial infarction (STEMI).

The purpose of the present guideline is to focus on the numerous advances in the diagnosis and management of patients with STEMI since 1999. This is reflected in the changed name of the guideline: "ACC/AHA Guidelines for the Management of Patients With ST-Elevation Myocardial Infarction." It is recognized that there are areas of overlap among this guideline on patients with STEMI, the guideline on patients with UA/NSTEMI, and other guidelines. The guideline committee has handled this overlap by reiterating important concepts and recommendations in this guideline and by providing cross-references to other guidelines.

Writing Committee

Writing committee members were selected with attention to cardiovascular subspecialties, broad geographical representation, and involvement in academic medicine and primary practice, including neurology, emergency medicine, and nursing. The Writing Committee on the Management of Patients with ST-Elevation Myocardial Infarction also included members of the American College of

Cardiology Foundation (ACCF) Board of Governors, the American Academy of Family Physicians (AAFP), and the Canadian Cardiovascular Society (CCS).

Writing groups were specifically charged to perform a formal literature review, weigh the strength of evidence for or against a particular treatment or procedure, and include estimates of expected health outcomes where data exist.

Recommendation Development Process

The final recommendations for indications for a diagnostic procedure, a particular therapy, or an intervention in patients with STEMI summarize both clinical evidence and expert opinion. Once recommendations were written, a Classification of Recommendation and Level of Evidence grade was assigned to each recommendation. Classification of Recommendations and Level of Evidence are expressed in the ACC/AHA format.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Class I: Conditions for which there is evidence and/or general agreement that a given procedure or treatment is beneficial, useful, and effective.

Class II: Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.

Class IIa: Weight of evidence/opinion is in favor of usefulness/efficacy.

Class IIb: Usefulness/efficacy is less well established by evidence/opinion.

Class III: Conditions for which there is evidence and/or general agreement that a procedure/treatment is not useful/effective and in some cases may be harmful.

COST ANALYSIS

The guideline developers reviewed published cost analyses.

METHOD OF GUIDELINE VALIDATION

External Peer Review
Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

The document was reviewed by three outside reviewers nominated by the American College of Cardiology (ACC) and three outside reviewers nominated by the American Heart Association (AHA), as well as one reviewer each from the American Academy of Family Physicians (AAFP) and the Canadian Cardiovascular Society (CCS), and 58 individual content reviewers.

The document was approved for publication by the governing bodies of the ACC Foundation and the AHA, and endorsed by the CCS.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

The final recommendations for indications for a diagnostic procedure, a particular therapy, or an intervention in patients with ST-elevation myocardial infarction (STEMI) summarize both clinical evidence and expert opinion. Once recommendations were written, a Classification of Recommendation and Level of Evidence grade were assigned to each recommendation. Classification of Recommendations and Level of Evidence are expressed in the ACC/AHA format and are defined at the end of the "Major Recommendations" field.

Management Before STEMI

Identification of Patients at Risk of STEMI

Class I

1. Primary care providers should evaluate the presence and status of control of major risk factors for coronary heart disease (CHD) for all patients at regular intervals (approximately every 3 to 5 years). (Level of Evidence: C)
2. Ten-year risk (National Cholesterol Education Program [NCEP] global risk) of developing symptomatic CHD should be calculated for all patients who have 2 or more major risk factors to assess the need for primary prevention strategies. (Level of Evidence: B)
3. Patients with established CHD should be identified for secondary prevention, and patients with a CHD risk equivalent (e.g., diabetes mellitus, chronic kidney disease, or 10-year risk greater than 20% as calculated by Framingham equations) should receive equally intensive risk factor intervention as those with clinically apparent CHD. (Level of Evidence: A)

Patient Education for Early Recognition and Response to STEMI

Class I

1. Patients with symptoms of STEMI (chest discomfort with or without radiation to the arms[s], back, neck, jaw, or epigastrium; shortness of breath; weakness; diaphoresis; nausea; lightheadedness) should be transported to the hospital by ambulance rather than by friends or relatives. (Level of Evidence: B)
2. Health care providers should actively address the following issues regarding STEMI with patients and their families:
 - a. The patient's heart attack risk (Level of Evidence: C)
 - b. How to recognize symptoms of STEMI (Level of Evidence: C)
 - c. The advisability of calling 9-1-1 if symptoms are unimproved or worsening after 5 minutes, despite feelings of uncertainty about the symptoms and fear of potential embarrassment (Level of Evidence: C)
 - d. A plan for appropriate recognition and response to a potential acute cardiac event that includes the phone number to access emergency medical services (EMS), generally 9-1-1. (Level of Evidence: C)

3. Health care providers should instruct patients for whom nitroglycerin has been prescribed previously to take ONE nitroglycerin dose sublingually in response to chest discomfort/pain. If chest discomfort/pain is unimproved or worsening 5 minutes after 1 sublingual nitroglycerin dose has been taken, it is recommended that the patient or family member/friend call 9-1-1 immediately to access EMS. (Level of Evidence: C)

Onset of STEMI

Out-of-Hospital Cardiac Arrest

Class I

1. All communities should create and maintain a strong "Chain of Survival" for out-of-hospital cardiac arrest that includes early access (recognition of the problem and activation of the EMS system by a bystander), early cardiopulmonary resuscitation (CPR), early defibrillation for patients who need it, and early advanced cardiac life support (ACLS). (Level of Evidence: C)
2. Family members of patients experiencing STEMI should be advised to take CPR training and familiarize themselves with the use of an automated external defibrillator (AED). In addition, they should be referred to a CPR training program that has a social support component for family members of post-STEMI patients. (Level of Evidence: B)

Prehospital Issues

Emergency Medical Services (EMS) Systems

Class I

1. All EMS first responders who respond to patients with chest pain and/or suspected cardiac arrest should be trained and equipped to provide early defibrillation. (Level of Evidence: A)
2. All public safety first responders who respond to patients with chest pain and/or suspected cardiac arrest should be trained and equipped to provide early defibrillation with AEDs. (Provision of early defibrillation with AEDs by nonpublic safety first responders is a promising new strategy, but further study is needed to determine its safety and efficacy.) (Level of Evidence: B)
3. Dispatchers staffing 9-1-1 center emergency medical calls should have medical training, should use nationally developed and maintained protocols, and should have a quality-improvement system in place to ensure compliance with protocols. (Level of Evidence: C)

Prehospital Chest Pain Evaluation and Treatment

Class I

1. Prehospital EMS providers should administer 162 to 325 mg of aspirin (chewed) to chest pain patients suspected of having STEMI unless contraindicated or already taken by patient. Although some trials have used

enteric-coated aspirin for initial dosing, more rapid buccal absorption occurs with non-enteric-coated formulations. (Level of Evidence: C)

Class IIa

1. It is reasonable for all 9-1-1 dispatchers to advise patients without a history of aspirin allergy who have symptoms of STEMI to chew aspirin (162 to 325 mg) while awaiting arrival of prehospital EMS providers. Although some trials have used enteric-coated aspirin for initial dosing, more rapid buccal absorption occurs with non-enteric-coated formulations. (Level of Evidence: C)
2. It is reasonable that all ACLS providers perform and evaluate 12-lead electrocardiograms (ECGs) routinely on chest pain patients suspected of STEMI. (Level of Evidence: B)
3. If the ECG shows evidence of STEMI, it is reasonable that prehospital ACLS providers review a reperfusion "checklist" and relay the ECG and checklist findings to a predetermined medical control facility and/or receiving hospital. (Level of Evidence: C)

Prehospital Fibrinolysis

Class IIa

1. Establishment of a prehospital fibrinolysis protocol is reasonable in 1) settings in which physicians are present in the ambulance or in 2) well-organized EMS systems with full-time paramedics who have 12-lead ECGs in the field with transmission capability, paramedic initial and ongoing training in ECG interpretation and STEMI treatment, online medical command, a medical director with training/experience in STEMI management, and an ongoing continuous quality-improvement program. (Level of Evidence: B)

Prehospital Destination Protocols

Class I

1. Patients with STEMI who have cardiogenic shock and are less than 75 years of age should be brought immediately or secondarily transferred to facilities capable of cardiac catheterization and rapid revascularization (percutaneous coronary intervention [PCI] or coronary artery bypass graft surgery [CABG]) if it can be performed within 18 hours of onset of shock. (Level of Evidence: A)
2. Patients with STEMI who have contraindications to fibrinolytic therapy should be brought immediately or secondarily transferred promptly (i.e., primary receiving hospital door-to-departure time less than 30 minutes) to facilities capable of cardiac catheterization and rapid revascularization (PCI or CABG). (Level of Evidence: B)
3. Every community should have a written protocol that guides EMS system personnel in determining where to take patients with suspected or confirmed STEMI. (Level of Evidence: C)

Class IIa

1. It is reasonable that patients with STEMI who have cardiogenic shock and are 75 years of age or older be considered for immediate or prompt secondary transfer to facilities capable of cardiac catheterization and rapid revascularization (PCI or CABG) if it can be performed within 18 hours of onset of shock. (Level of Evidence: B)
2. It is reasonable that patients with STEMI who are at especially high risk of dying, including those with severe congestive heart failure (CHF), be considered for immediate or prompt secondary transfer (i.e., primary-receiving hospital door-to-departure time less than 30 minutes) to facilities capable of cardiac catheterization and rapid revascularization (PCI or CABG). (Level of Evidence: B)

Initial Recognition and Management in the Emergency Department (ED)

Optimal strategies for ED triage

Class I

1. Hospitals should establish multidisciplinary teams (including primary care physicians, emergency medicine physicians, cardiologists, nurses, and laboratorians) to develop guideline-based, institution-specific written protocols for triaging and managing patients who are seen in the prehospital setting or present to the ED with symptoms suggestive of STEMI. (Level of Evidence: B)

Initial Patient Evaluation

Class I

1. The delay from patient contact with the health care system (typically, arrival at the ED or contact with paramedics) to initiation of fibrinolytic therapy should be less than 30 minutes. Alternatively, if PCI is chosen, the delay from patient contact with the healthcare system (typically, arrival at the ED or contact with paramedics) to balloon inflation should be less than 90 minutes. (Level of Evidence: B)
2. The choice of initial STEMI treatment should be made by the emergency medicine physician on duty based on a predetermined, institution-specific, written protocol that is a collaborative effort of cardiologists (both those involved in coronary care unit management and interventionalists), emergency physicians, primary care physicians, nurses, and other appropriate personnel. For cases in which the initial diagnosis and treatment plan is unclear to the emergency physician or is not covered directly by the agreed-on protocol, immediate cardiology consultation is advisable. (Level of Evidence: C)

History

Class I

1. The targeted history of STEMI patients taken in the ED should ascertain whether the patient has had prior episodes of myocardial ischemia such as

stable or unstable angina, MI, CABG, or PCI. Evaluation of the patient's complaints should focus on chest discomfort, associated symptoms, sex- and age-related differences in presentation, hypertension, diabetes mellitus, possibility of aortic dissection, risk of bleeding, and clinical cerebrovascular disease (amaurosis fugax, face/limb weakness or clumsiness, face/limb numbness or sensory loss, ataxia, or vertigo). (Level of Evidence: C)

Physical Examination

Class I

1. A physical examination should be performed to aid in the diagnosis and assessment of the extent, location, and presence of complications of STEMI. (Level of Evidence: C)
2. A brief, focused, and limited neurological examination to look for evidence of prior stroke or cognitive deficits should be performed on STEMI patients before administration of fibrinolytic therapy. (Level of Evidence: C)

Electrocardiogram

Class I

1. A 12-lead ECG should be performed and shown to an experienced emergency physician within 10 minutes of ED arrival for all patients with chest discomfort (or anginal equivalent) or other symptoms suggestive of STEMI. (Level of Evidence: C)
2. If the initial ECG is not diagnostic of STEMI but the patient remains symptomatic, and there is a high clinical suspicion for STEMI, serial ECGs at 5- to 10-minute intervals or continuous 12-lead ST-segment monitoring should be performed to detect the potential development of ST elevation. (Level of Evidence: C)
3. In patients with inferior STEMI, right-sided ECG leads should be obtained to screen for ST elevation suggestive of right ventricular (RV) infarction. (See Section 7.6.6 of the full-text guidelines and the ACC/AHA/ASE 2003 Guideline Update for the Clinical Application of Echocardiography.) (Level of Evidence: B)

Laboratory Examinations

Class I

1. Laboratory examinations should be performed as part of the management of STEMI patients but should not delay the implementation of reperfusion therapy. (Level of Evidence: C)

Biomarkers of Cardiac Damage

Class I

1. Cardiac-specific troponins should be used as the optimum biomarkers for the evaluation of patients with STEMI who have coexistent skeletal muscle injury. (Level of Evidence: C)
2. For patients with ST elevation on the 12-lead ECG and symptoms of STEMI, reperfusion therapy should be initiated as soon as possible and is not contingent on a biomarker assay. (Level of Evidence: C)

Class IIa

1. Serial biomarker measurements can be useful to provide supportive noninvasive evidence of reperfusion of the infarct artery after fibrinolytic therapy in patients not undergoing angiography within the first 24 hours after fibrinolytic therapy. (Level of Evidence: B)

Class III

1. Serial biomarker measurements should not be relied on to diagnose reinfarction within the first 18 hours after the onset of STEMI. (Level of Evidence: C)

Bedside Testing for Serum Cardiac Biomarkers

Class I

1. Although handheld bedside (point-of-care) assays may be used for a qualitative assessment of the presence of an elevated level of a serum cardiac biomarker, subsequent measurements of cardiac biomarker levels should be performed with a quantitative test. (Level of Evidence: B)
2. For patients with ST elevation on the 12-lead ECG and symptoms of STEMI, reperfusion therapy should be initiated as soon as possible and is not contingent on a bedside biomarker assay. (Level of Evidence: C)

Imaging

Class I

1. Patients with STEMI should have a portable chest x-ray, but this should not delay implementation of reperfusion therapy (unless a potential contraindication, such as aortic dissection, is suspected). (Level of Evidence: C)
2. Imaging studies such as a high-quality portable chest x-ray, transthoracic and/or transesophageal echocardiography, and a contrast chest computed tomographic scan or a magnetic resonance imaging (MRI) scan should be used to differentiate STEMI from aortic dissection in patients for whom this distinction is initially unclear. (Level of Evidence: B)

Class IIa

1. Portable echocardiography is reasonable to clarify the diagnosis of STEMI and allow risk stratification of patients with chest pain on arrival at the ED, especially if the diagnosis of STEMI is confounded by left bundle-branch block

(LBBB) or pacing, or there is suspicion of posterior STEMI with anterior ST depressions. (See Section 7.6.7 Mechanical Causes of Heart Failure/Low Output Syndrome in the full-text guidelines.) (Level of Evidence: B)

Class III

1. Single-photon emission computed tomography (SPECT) radionuclide imaging should not be performed to diagnose STEMI in patients for whom the diagnosis of STEMI is evident on the ECG. (Level of Evidence: B)

Management

Routine Measures

Oxygen

Class I

1. Supplemental oxygen should be administered to patients with arterial oxygen desaturation (SaO_2 less than 90%). (Level of Evidence: B)

Class IIa

1. It is reasonable to administer supplemental oxygen to all patients with uncomplicated STEMI during the first 6 hours. (Level of Evidence: C)

Nitroglycerin

Class I

1. Patients with ongoing ischemic discomfort should receive sublingual nitroglycerin (0.4 mg) every 5 minutes for a total of 3 doses, after which an assessment should be made about the need for intravenous nitroglycerin. (Level of Evidence: C)
2. Intravenous nitroglycerin is indicated for relief of ongoing ischemic discomfort, control of hypertension, or management of pulmonary congestion. (Level of Evidence: C)

Class III

1. Nitrates should not be administered to patients with systolic blood pressure less than 90 mm Hg or greater than or equal to 30 mm Hg below baseline, severe bradycardia (less than 50 beats per minute), tachycardia (more than 100 bpm), or suspected RV infarction. (Level of Evidence: C)
2. Nitrates should not be administered to patients who have received a phosphodiesterase inhibitor for erectile dysfunction within the last 24 hours (48 hours for tadalafil). (Level of Evidence: B)

Analgesia

Class I

1. Morphine sulfate (2 to 4 mg intravenously [IV] with increments of 2 to 8 mg IV repeated at 5- to 15-minute intervals) is the analgesic of choice for management of pain associated with STEMI. (Level of Evidence: C)

Aspirin

Class I

1. Aspirin should be chewed by patients who have not taken aspirin before presentation with STEMI. The initial dose should be 162 mg (Level of Evidence: A) to 325 mg (Level of Evidence: C). Although some trials have used enteric-coated aspirin for initial dosing, more rapid buccal absorption occurs with non-enteric-coated aspirin formulations.

Beta-Blockers

Class I

1. Oral beta-blocker therapy should be administered promptly to those patients without a contraindication, irrespective of concomitant fibrinolytic therapy or performance of primary PCI. (Level of Evidence: A)

Class IIa

1. It is reasonable to administer IV beta-blockers promptly to STEMI patients without contraindications, especially if a tachyarrhythmia or hypertension is present. (Level of Evidence: B)

Reperfusion

- General Concepts

Class I

1. All STEMI patients should undergo rapid evaluation for reperfusion therapy and have a reperfusion strategy implemented promptly after contact with the medical system. (Level of Evidence: A)
- Selection of Reperfusion Strategy

Several issues should be considered in selecting the type of reperfusion therapy:

- Time from onset of symptoms
- Risk of STEMI
- Risk of bleeding
- Time required for transport to a skilled PCI laboratory

A. Available Resources

Class I

1. STEMI patients presenting to a facility without the capability for expert, prompt intervention with primary PCI within 90 minutes of first medical contact should undergo fibrinolysis unless contraindicated. (Level of Evidence: A)
- Pharmacological Reperfusion
 - A. Indications for Fibrinolytic Therapy

Class I

1. In the absence of contraindications, fibrinolytic therapy should be administered to STEMI patients with symptom onset within the prior 12 hours and ST elevation greater than 0.1 mV in at least 2 contiguous precordial leads or at least 2 adjacent limb leads. (Level of Evidence: A)
2. In the absence of contraindications, fibrinolytic therapy should be administered to STEMI patients with symptom onset within the prior 12 hours and new or presumably new LBBB. (Level of Evidence: A)

Class IIa

1. In the absence of contraindications, it is reasonable to administer fibrinolytic therapy to STEMI patients with symptom onset within the prior 12 hours and 12-lead ECG findings consistent with a true posterior MI. (Level of Evidence: C)
2. In the absence of contraindications, it is reasonable to administer fibrinolytic therapy to patients with symptoms of STEMI beginning within the prior 12 to 24 hours who have continuing ischemic symptoms and ST elevation greater than 0.1 mV in at least 2 contiguous precordial leads or at least 2 adjacent limb leads. (Level of Evidence: B)

Class III

1. Fibrinolytic therapy should not be administered to asymptomatic patients whose initial symptoms of STEMI began more than 24 hours earlier. (Level of Evidence: C)
 2. Fibrinolytic therapy should not be administered to patients whose 12-lead ECG shows only ST-segment depression except if a true posterior MI is suspected. (Level of Evidence: A)
- B. Contraindications/Cautions

Class I

1. Health care providers should ascertain whether the patient has neurological contraindications to fibrinolytic therapy, including any history of intracranial hemorrhage (ICH), significant closed head or facial trauma within the past 3 months, uncontrolled hypertension, or ischemic stroke within the past 3 months.

- (See Table 2 in the guideline executive summary for a comprehensive list.) (Level of Evidence: A)
2. STEMI patients at substantial (greater than or equal to 4%) risk of ICH should be treated with PCI rather than with fibrinolytic therapy. (See Figure 3 in the guideline executive summary for further management considerations.) (Level of Evidence: A)
- C. Complications of Fibrinolytic Therapy: Neurological and Other

Class I

1. The occurrence of a change in neurological status during or after reperfusion therapy, particularly within the first 24 hours after initiation of treatment, is considered to be due to ICH until proven otherwise. Fibrinolytic, antiplatelet, and anticoagulant therapies should be discontinued until brain imaging scan shows no evidence of ICH. (Level of Evidence: A)
2. Neurology and/or neurosurgery or hematology consultations should be obtained for STEMI patients who have ICH, as dictated by clinical circumstances. (Level of Evidence: C)
3. In patients with ICH, infusions of cryoprecipitate, fresh frozen plasma, protamine, and platelets should be given, as dictated by clinical circumstances. (Level of Evidence: C)

Class II a

1. In patients with ICH, it is reasonable to:
 - a. Optimize blood pressure and blood glucose levels. (Level of Evidence: C)
 - b. Reduce intracranial pressure with an infusion of mannitol, endotracheal intubation, and hyperventilation. (Level of Evidence: C)
 - c. Consider neurosurgical evacuation of ICH. (Level of Evidence: C)
- D. Combination Therapy with Glycoprotein IIb/IIIa Inhibitors

Class II b

1. Combination pharmacological reperfusion with abciximab and half-dose reteplase or tenecteplase may be considered for prevention of reinfarction (Level of Evidence: A) and other complications of STEMI in selected patients: anterior location of MI, age less than 75 years, and no risk factors for bleeding. In two clinical trials of combination reperfusion, the prevention of reinfarction did not translate into a survival benefit at either 30 days or 1 year. (Level of Evidence: B)
2. Combination pharmacological reperfusion with abciximab and half-dose reteplase or tenecteplase may be considered for prevention of reinfarction and other complications of STEMI in selected patients (anterior location of MI, age less than 75 years, and no risk factors for bleeding) in whom an early referral for angiography and PCI (i.e., facilitated PCI) is planned. (Level of Evidence: C)

Class III

1. Combination pharmacological reperfusion with abciximab and half-dose reteplase or tenecteplase should not be given to patients aged greater than 75 years because of an increased risk of ICH. (Level of Evidence: B)
- Percutaneous Coronary Intervention
 - A. Coronary Angiography

Class I

1. Diagnostic coronary angiography should be performed:
 - a. In candidates for primary or rescue PCI. (Level of Evidence: A)
 - b. In patients with cardiogenic shock who are candidates for revascularization. (Level of Evidence: A)
 - c. In candidates for surgical repair of ventricular septal rupture or severe mitral regurgitation (MR). (Level of Evidence: B)
 - d. In patients with persistent hemodynamic and/or electrical instability. (Level of Evidence: C)

Class III

1. Coronary angiography should not be performed in patients with extensive comorbidities in whom the risks of revascularization are likely to outweigh the benefits. (Level of Evidence: C)
- B. Primary PCI

Class I

1. General considerations: If immediately available, primary PCI should be performed in patients with STEMI (including true posterior MI) or MI with new or presumably new LBBB who can undergo PCI of the infarct artery within 12 hours of symptom onset, if performed in a timely fashion (balloon inflation within 90 minutes of presentation) by persons skilled in the procedure (individuals who perform more than 75 PCI procedures per year). The procedure should be supported by experienced personnel in an appropriate laboratory environment (performs more than 200 PCI procedures per year, of which at least 36 are primary PCI for STEMI, and has cardiac surgery capability). (Level of Evidence: A)
2. Specific considerations:
 - a. Primary PCI should be performed as quickly as possible, with a goal of a medical contact-to-balloon or door-to-balloon time of within 90 minutes. (Level of Evidence: B)
 - b. If the symptom duration is within 3 hours and the expected door-to-balloon time minus the expected door-to-needle time is:
 - i. within 1 hour, primary PCI is generally preferred. (Level of Evidence: B)

- ii. greater than 1 hour, fibrinolytic therapy (fibrin-specific agents) is generally preferred. (Level of Evidence: B)
- c. If symptom duration is greater than 3 hours, primary PCI is generally preferred and should be performed with a medical contact-to-balloon or door-to-balloon time as brief as possible, with a goal of within 90 minutes. (Level of Evidence: B)
- d. Primary PCI should be performed for patients younger than 75 years old with ST elevation or LBBB who develop shock within 36 hours of MI and are suitable for revascularization that can be performed within 18 hours of shock, unless further support is futile because of the patient's wishes or contraindications/unsuitability for further invasive care. (Level of Evidence: A)
- e. Primary PCI should be performed in patients with severe CHF and/or pulmonary edema (Killip class 3) and onset of symptoms within 12 hours. The medical contact-to-balloon or door-to-balloon time should be as short as possible (i.e., goal within 90 minutes). (Level of Evidence: B)

Class II a

- 1. Primary PCI is reasonable for selected patients 75 years or older with ST elevation or LBBB or who develop shock within 36 hours of MI and are suitable for revascularization that can be performed within 18 hours of shock. Patients with good prior functional status who are suitable for revascularization and agree to invasive care may be selected for such an invasive strategy. (Level of Evidence: B)
- 2. It is reasonable to perform primary PCI for patients with onset of symptoms within the prior 12 to 24 hours and 1 or more of the following:
 - a. Severe CHF (Level of Evidence: C)
 - b. Hemodynamic or electrical instability (Level of Evidence: C)
 - c. Persistent ischemic symptoms. (Level of Evidence: C)

Class II b

- 1. The benefit of primary PCI for STEMI patients eligible for fibrinolysis is not well established when performed by an operator who performs fewer than 75 PCI procedures per year. (Level of Evidence: C)

Class III

- 1. PCI should not be performed in a noninfarct artery at the time of primary PCI in patients without hemodynamic compromise. (Level of Evidence: C)

2. Primary PCI should not be performed in asymptomatic patients more than 12 hours after onset of STEMI if they are hemodynamically and electrically stable. (Level of Evidence: C)

Primary PCI in Fibrinolytic-Ineligible Patients

Class I

1. Primary PCI should be performed in fibrinolytic-ineligible patients who present with STEMI within 12 hours of symptom onset. (Level of Evidence: C)

Class II a

1. It is reasonable to perform primary PCI for fibrinolytic-ineligible patients with onset of symptoms within the prior 12 to 24 hours and 1 or more of the following:
 - a. Severe CHF (Level of Evidence: C)
 - b. Hemodynamic or electrical instability (Level of Evidence: C)
 - c. Persistent ischemic symptoms. (Level of Evidence: C)

Primary PCI Without On-Site Cardiac Surgery

Class II b

1. Primary PCI might be considered in hospitals without on-site cardiac surgery, provided that there exists a proven plan for rapid transport to a cardiac surgery operating room in a nearby hospital with appropriate hemodynamic support capability for transfer. The procedure should be limited to patients with STEMI or MI with new, or presumably new, LBBB on ECG, and should be done in a timely fashion (balloon inflation within 90 minutes of presentation) by persons skilled in the procedure (at least 75 PCIs per year) and at hospitals that perform a minimum of 36 primary PCI procedures per year. (Level of Evidence: B)

Class III

1. Primary PCI should not be performed in hospitals without on-site cardiac surgery and without a proven plan for rapid transport to a cardiac surgery operating room in a nearby hospital or without appropriate hemodynamic support capability for transfer. (Level of Evidence: C)

Interhospital Transfer for Primary PCI

C. Facilitated PCI

Class II b

1. Facilitated PCI might be performed as a reperfusion strategy in higher-risk patients when PCI is not immediately available and bleeding risk is low. (Level of Evidence: B)

D. Rescue PCI

Class I

1. Rescue PCI should be performed in patients less than 75 years old with ST elevation or LBBB who develop shock within 36 hours of MI and are suitable for revascularization that can be performed within 18 hours of shock, unless further support is futile because of the patient's wishes or contraindications/unsuitability for further invasive care. (Level of Evidence: B)
2. Rescue PCI should be performed in patients with severe CHF and/or pulmonary edema (Killip class 3) and onset of symptoms within 12 hours. (Level of Evidence: B)

Class IIa

1. Rescue PCI is reasonable for selected patients 75 years or older with ST elevation or LBBB or who develop shock within 36 hours of MI and are suitable for revascularization that can be performed within 18 hours of shock. Patients with good prior functional status who are suitable for revascularization and agree to invasive care may be selected for such an invasive strategy. (Level of Evidence: B)
2. It is reasonable to perform rescue PCI for patients with 1 or more of the following:
 - a. Hemodynamic or electrical instability (Level of Evidence: C)
 - b. Persistent ischemic symptoms. (Level of Evidence: C)

E. PCI for Cardiogenic Shock

Class I

1. Primary PCI is recommended for patients less than 75 years old with ST elevation or LBBB who develop shock within 36 hours of MI and are suitable for revascularization that can be performed within 18 hours of shock, unless further support is futile because of the patient's wishes or contraindications/unsuitability for further invasive care. (Level of Evidence: A)

Class IIa

1. Primary PCI is reasonable for selected patients aged 75 years or older with ST elevation or LBBB who develop shock within 36 hours of MI and who are suitable for revascularization that can be performed within 18 hours of shock. Patients with good prior functional status who are suitable for revascularization and

agree to invasive care may be selected for such an invasive strategy. (Level of Evidence: B)

F. Percutaneous Coronary Intervention After Fibrinolysis

Class I

1. In patients whose anatomy is suitable, PCI should be performed when there is objective evidence of recurrent MI. (Level of Evidence: C)
2. In patients whose anatomy is suitable, PCI should be performed for moderate or severe spontaneous or provokable myocardial ischemia during recovery from STEMI. (Level of Evidence: B)
3. In patients whose anatomy is suitable, PCI should be performed for cardiogenic shock or hemodynamic instability. (Level of Evidence: B)

Class IIa

1. It is reasonable to perform routine PCI in patients with LV ejection fraction (LVEF) less than or equal to 0.40, CHF or serious ventricular arrhythmias. (Level of Evidence: C)
2. It is reasonable to perform PCI when there is documented clinical heart failure during the acute episode, even though subsequent evaluation shows preserved LV function (LVEF greater than 0.40). (Level of Evidence: C)

Class IIb

1. Routine PCI might be considered as part of an invasive strategy after fibrinolytic therapy. (Level of Evidence: B)

- Acute Surgical Reperfusion

Class I

1. Emergency or urgent CABG in patients with STEMI should be undertaken in the following circumstances:
 - a. Failed PCI with persistent pain or hemodynamic instability in patients with coronary anatomy suitable for surgery. (Level of Evidence: B)
 - b. Persistent or recurrent ischemia refractory to medical therapy in patients who have coronary anatomy suitable for surgery, have a significant area of myocardium at risk, and are not candidates for PCI or fibrinolytic therapy. (Level of Evidence: B)
 - c. At the time of surgical repair of postinfarction ventricular septal rupture (VSR) or mitral valve insufficiency. (Level of Evidence: B)
 - d. Cardiogenic shock in patients less than 75 years old with ST elevation, LBBB, or posterior MI who develop shock within 36 hours of STEMI, have severe multivessel or left main disease, and are suitable for revascularization that can be performed

within 18 hours of shock, unless further support is futile because of the patient's wishes or contraindications/unsuitability for further invasive care. (Level of Evidence: A)

- e. Life-threatening ventricular arrhythmias in the presence of greater than or equal to 50% left main stenosis and/or triple-vessel disease. (Level of Evidence: B)

Class II a

1. Emergency CABG can be useful as the primary reperfusion strategy in patients who have suitable anatomy, who are not candidates for fibrinolysis or PCI, and who are in the early hours (6 to 12 hours) of an evolving STEMI, especially if severe multivessel or left main disease is present. (Level of Evidence: B)
2. Emergency CABG can be effective in selected patients 75 years or older with ST elevation, LBBB, or posterior MI who develop shock within 36 hours of STEMI, have severe triple-vessel or left main disease, and are suitable for revascularization that can be performed within 18 hours of shock. Patients with good prior functional status who are suitable for revascularization and agree to invasive care may be selected for such an invasive strategy. (Level of Evidence: B)

Class III

1. Emergency CABG should not be performed in patients with persistent angina and a small area of risk if they are hemodynamically stable. (Level of Evidence: C)
 2. Emergency CABG should not be performed in patients with successful epicardial reperfusion but unsuccessful microvascular reperfusion. (Level of Evidence: C)
- Patients with STEMI not Receiving Reperfusion

Guideline-based recommendations for non-reperfusion treatments should not vary whether or not patients received reperfusion therapy. The major difference is that patients not receiving reperfusion therapy are considered to have a higher risk for future adverse events.

- Assessment of Reperfusion

Class II a

1. It is reasonable to monitor the pattern of ST elevation, cardiac rhythm, and clinical symptoms over the 60 to 180 minutes after initiation of fibrinolytic therapy. Noninvasive findings suggestive of reperfusion include relief of symptoms, maintenance or restoration of hemodynamic and or electrical stability, and a reduction of at least 50% of the initial ST-segment elevation injury pattern on a follow-up ECG 60 to 90 minutes after initiation of therapy. (Level of Evidence: B)
- Ancillary Therapy

A. Antithrombins as Ancillary Therapy to Reperfusion Therapy

Unfractionated Heparin (UFH) As Ancillary Therapy To Reperfusion Therapy

Class I

1. Patients undergoing percutaneous or surgical revascularization should be given UFH. (Level of Evidence: C)
2. UFH should be given intravenously to patients undergoing reperfusion therapy with alteplase, reteplase, or tenecteplase, with dosing as follows: bolus of 60 U/kg (maximum 4,000 U) followed by an initial infusion of 12 U/kg per hour (maximum 1,000 U/hr) adjusted to maintain activated partial thromboplastin time (aPTT) at 1.5 to 2.0 times control (approximately 50 to 70 seconds). (Level of Evidence: C)
3. UFH should be given intravenously to patients treated with nonselective fibrinolytic agents (streptokinase, anistreplase, or urokinase) who are at high risk for systemic emboli (large or anterior MI, atrial fibrillation, previous embolus, or known LV thrombus). (Level of Evidence: B)
4. Platelet counts should be monitored daily in patients given UFH. (Level of Evidence: C)

Class II b

1. It may be reasonable to administer UFH intravenously to patients undergoing reperfusion therapy with streptokinase. (Level of Evidence: B)

Low-Molecular-Weight Heparin (LMWH) as Ancillary Therapy to Reperfusion Therapy

Class II b

1. LMWH might be considered an acceptable alternative to UFH as ancillary therapy for patients less than 75 years of age who are receiving fibrinolytic therapy, provided that significant renal dysfunction (serum creatinine greater than 2.5 mg/dL in men or 2.0 mg/dL in women) is not present. Enoxaparin (30 mg IV bolus followed by 1.0 mg/kg subcutaneous injection every 12 hours until hospital discharge) used in combination with full-dose tenecteplase is the most comprehensively studied regimen in patients less than 75 years of age. (Level of Evidence: B)

Class III

1. LMWH should not be used as an alternative to UFH as ancillary therapy in patients over 75 years of age who are receiving fibrinolytic therapy. (Level of Evidence: B)

2. LMWH should not be used as an alternative to UFH as ancillary therapy in patients less than 75 years of age who are receiving fibrinolytic therapy but have significant renal dysfunction (serum creatinine greater than 2.5 mg/dL in men or 2.0 mg/dL in women). (Level of Evidence: B)

Direct Antithrombins As Ancillary Therapy to Reperfusion Therapy

Class IIa

1. In patients with known heparin-induced thrombocytopenia, it is reasonable to consider bivalirudin as a useful alternative to heparin to be used in conjunction with streptokinase. Dosing according to the Hirulog and Early Reperfusion or Occlusion (HERO)-2 regimen (a bolus of 0.25 mg/kg followed by an intravenous infusion of 0.5 mg/kg per hour for the first 12 hours and 0.25 mg/kg per hour for the subsequent 36 hours) is recommended but with a reduction in the infusion rate if the PTT is above 75 seconds within the first 12 hours. (Level of Evidence: B)

B. Antiplatelets

Aspirin

Class I

1. A daily dose of aspirin (initial dose of 162 to 325 mg orally; maintenance dose of 75 to 162 mg) should be given indefinitely after STEMI to all patients without a true aspirin allergy. (Level of Evidence: A)

Thienopyridines

Class I

1. In patients who have undergone diagnostic cardiac catheterization and for whom PCI is planned, clopidogrel should be started and continued for at least 1 month after bare metal stent implantation, for several months after drug-eluting stent implantation (3 months for sirolimus, 6 months for paclitaxel), and for up to 12 months in patients who are not at high risk for bleeding. (Level of Evidence: B)
2. In patients taking clopidogrel in whom CABG is planned, the drug should be withheld for at least 5 days, and preferably for 7, unless the urgency for revascularization outweighs the risks of excess bleeding. (Level of Evidence: B)

Class IIa

1. Clopidogrel is probably indicated in patients receiving fibrinolytic therapy who are unable to take aspirin because of

hypersensitivity or major gastrointestinal intolerance. (Level of Evidence: C)

Glycoprotein IIb/IIIa Inhibitors

Class IIa

1. It is reasonable to start treatment with abciximab as early as possible before primary PCI (with or without stenting) in patients with STEMI. (Level of Evidence: B)

Class IIb

1. Treatment with tirofiban or eptifibatide may be considered before primary PCI (with or without stenting) in patients with STEMI. (Level of Evidence: C)

The Writing Committee believes that it is reasonable to start treatment with abciximab as early as possible in patients undergoing primary PCI (with or without stenting) but, given the size and limitations of the available data set, assigned a Class IIa recommendation to this treatment. The data on tirofiban and eptifibatide in primary PCI are far more limited than for abciximab. However, given the common mode of action of the agents, a modest amount of angiographic data, and general clinical experience to date, tirofiban or eptifibatide may be useful as antiplatelet therapy to support primary PCI for STEMI (with or without stenting) (Class IIb recommendation).

- Other Pharmacological Measures
 - A. Inhibition of Renin-Angiotensin-Aldosterone System

Class I

1. An angiotensin-converting enzyme (ACE) inhibitor should be administered orally within the first 24 hours of STEMI to patients with anterior infarction, pulmonary congestion, or LVEF less than 0.40, in the absence of hypotension (systolic blood pressure less than 100 mm Hg or less than 30 mm Hg below baseline) or known contraindications to that Class of medications. (Level of Evidence: A)
2. An angiotensin receptor blocker (ARB) should be administered to STEMI patients who are intolerant of ACE inhibitors and who have either clinical or radiological signs of heart failure or LVEF less than 0.40. Valsartan and candesartan have established efficacy for this recommendation. (Level of Evidence: C)

Class IIa

1. An ACE inhibitor administered orally within the first 24 hours of STEMI can be useful in patients without anterior infarction, pulmonary congestion, or LVEF less than 0.40 in the absence of

hypotension (systolic blood pressure less than 100 mm Hg or less than 30 mm Hg below baseline) or known contraindications to that class of medications. The expected treatment benefit in such patients is less (5 lives saved per 1,000 patients treated) than for patients with LV dysfunction. (Level of Evidence: B)

Class III

1. An intravenous ACE inhibitor should not be given to patients within the first 24 hours of STEMI because of the risk of hypotension. (A possible exception may be patients with refractory hypertension.) (Level of Evidence: B)
- B. Metabolic Modulation of the Glucose-Insulin Axis

Strict Glucose Control During STEMI

Class I

1. An insulin infusion to normalize blood glucose is recommended for patients with STEMI and complicated courses. (Level of Evidence: B)

Class IIa

1. During the acute phase (first 24 to 48 hours) of the management of STEMI in patients with hyperglycemia, it is reasonable to administer an insulin infusion to normalize blood glucose, even in patients with an uncomplicated course. (Level of Evidence: B)
2. After the acute phase of STEMI, it is reasonable to individualize treatment of diabetics, selecting from a combination of insulin, insulin analogs, and oral hypoglycemic agents that achieve the best glycemic control and are well tolerated. (Level of Evidence: C)

C. Magnesium

Class IIa

1. It is reasonable that documented magnesium deficits be corrected, especially in patients receiving diuretics before the onset of STEMI. (Level of Evidence: C)
2. It is reasonable that episodes of torsade de pointes-type ventricular tachycardia (VT) associated with a prolonged QT interval be treated with 1 to 2 grams of magnesium administered as an intravenous bolus over 5 minutes. (Level of Evidence: C)

Class III

1. In the absence of documented electrolyte deficits or torsade de pointes-type VT, routine intravenous magnesium should not be

administered to STEMI patients at any level of risk. (Level of Evidence: A)

D. Calcium Channel Blockers

Class IIa

1. It is reasonable to give verapamil or diltiazem to patients in whom beta-blockers are ineffective or contraindicated (e.g., bronchospastic disease) for relief of ongoing ischemia or control of a rapid ventricular response with atrial fibrillation or flutter after STEMI in the absence of CHF, LV dysfunction, or atrioventricular (AV) block. (Level of Evidence: C)

Class III

1. Diltiazem and verapamil are contraindicated in patients with STEMI and associated systolic LV dysfunction and CHF. (Level of Evidence: A)
2. Nifedipine (immediate-release form) is contraindicated in treatment of STEMI because of the reflex sympathetic activation, tachycardia, and hypotension associated with its use. (Level of Evidence: B)

See the full-text guidelines for further explanation.

Hospital Management

Location

Coronary Care Unit

Class I

1. STEMI patients should be admitted to a quiet and comfortable environment that provides for continuous monitoring of the ECG and pulse oximetry and has ready access to facilities for hemodynamic monitoring and defibrillation. (Level of Evidence: C)
2. The patient's medication regimen should be reviewed to confirm the administration of aspirin and beta-blockers in an adequate dose to control heart rate and to assess the need for intravenous nitroglycerin for control of angina, hypertension, or heart failure. (Level of Evidence: A)
3. The ongoing need for supplemental oxygen should be assessed by monitoring arterial oxygen saturation. When stable for 6 hours, the patient should be reassessed for oxygen need (i.e., O₂ saturation of less than 90%), and discontinuation of supplemental oxygen should be considered. (Level of Evidence: C)
4. Nursing care should be provided by individuals certified in critical care, with staffing based on the specific needs of patients and provider competencies, as well as organizational priorities. (Level of Evidence: C)
5. Care of STEMI patients in the critical care unit (CCU) should be structured around protocols derived from practice guidelines. (Level of Evidence: C)

6. Electrocardiographic monitoring leads should be based on the location and rhythm to optimize detection of ST deviation, axis shift, conduction defects, and dysrhythmias. (Level of Evidence: B)

Class III

1. It is not an effective use of the CCU environment to admit terminally ill, "do not resuscitate" patients with STEMI, because clinical and comfort needs can be provided outside of a critical care environment. (Level of Evidence: C)

Stepdown Unit

Class I

1. It is a useful triage strategy to admit low-risk STEMI patients who have undergone successful PCI directly to the stepdown unit for post-PCI care rather than to the CCU. (Level of Evidence: C)
2. STEMI patients originally admitted to the CCU who demonstrate 12 to 24 hours of clinical stability (absence of recurrent ischemia, heart failure, or hemodynamically compromising dysrhythmias) should be transferred to the stepdown unit. (Level of Evidence: C)

Class IIa

1. It is reasonable for patients recovering from STEMI who have clinically symptomatic heart failure to be managed on the stepdown unit, provided that facilities for continuous monitoring of pulse oximetry and appropriately skilled nurses are available. (Level of Evidence: C)
2. It is reasonable for patients recovering from STEMI who have arrhythmias that are hemodynamically well-tolerated (e.g., atrial fibrillation with a controlled ventricular response; paroxysms of nonsustained VT lasting less than 30 seconds) to be managed on the stepdown unit, provided that facilities for continuous monitoring of the ECG, defibrillators, and appropriately skilled nurses are available. (Level of Evidence: C)

Class IIb

1. Patients recovering from STEMI who have clinically significant pulmonary disease requiring high-flow supplemental oxygen or noninvasive mask ventilation/ bilevel positive airway pressure (BIPAP)/continuous positive airway pressure (CPAP) may be considered for care on a stepdown unit provided that facilities for continuous monitoring of pulse oximetry and appropriately skilled nurses with a sufficient nurse:patient ratio are available. (Level of Evidence: C)

Early, General measures

Level of Activity

Class IIa

1. After 12 to 24 hours, it is reasonable to allow patients with hemodynamic instability or continued ischemia to have bedside commode privileges. (Level of Evidence: C)

Class III

1. Patients with STEMI who are free of recurrent ischemic discomfort, symptoms of heart failure, or serious disturbances of heart rhythm should not be on bed rest for more than 12 to 24 hours. (Level of Evidence: C)

Diet

Class I

1. Patients with STEMI should be prescribed the NCEP Adult Treatment Panel III (ATP III) Therapeutic Lifestyle Changes (TLC) diet, which focuses on reduced intake of fats and cholesterol, less than 7% of total calories as saturated fats, less than 200 mg of cholesterol per day, increased consumption of omega-3 fatty acids, and appropriate caloric intake for energy needs. (Level of Evidence: C)
2. Diabetic patients with STEMI should have an appropriate food group balance and caloric intake. (Level of Evidence: B)
3. Sodium intake should be restricted in STEMI patients with hypertension or heart failure. (Level of Evidence: B)

Patient Education in the Hospital Setting

Class I

1. Patient counseling to maximize adherence to evidence-based post-STEMI treatments (e.g., compliance with taking medication, exercise prescription, and smoking cessation) should begin during the early phase of hospitalization, occur intensively at discharge, and continue at follow-up visits with providers and through cardiac rehabilitation programs and community support groups, as appropriate. (Level of Evidence: C)
2. Critical pathways and protocols and other quality improvement tools (e.g., the American College of Cardiology (ACC) "Guidelines Applied in Practice" and the American Heart Association's (AHA's) "Get with the Guidelines") should be used to improve the application of evidence-based treatments by patients with STEMI, caregivers, and institutions. (Level of Evidence: C)

Analgesia/Anxiolytics

Class IIa

1. It is reasonable to use anxiolytic medications in STEMI patients to alleviate short-term anxiety or altered behavior related to hospitalization for STEMI. (Level of Evidence: C)
2. It is reasonable to routinely assess the patient's anxiety level and manage it with behavioral interventions and referral for counseling. (Level of Evidence: C)

Risk Stratification during early hospital course

Risk stratification is a continuous process and requires the updating of initial assessments with data obtained during the hospital stay. Indicators of failed reperfusion (e.g., recurrence of chest pain and persistence of ECG findings indicating infarction) identify a patient who should undergo coronary angiography. Similarly, findings consistent with mechanical complications (e.g., sudden onset of heart failure or presence of a new murmur) herald increased risk and suggest the need for rapid intervention. For patients who did not undergo primary reperfusion, changes in clinical status (e.g., development of shock) may herald a worsening clinical status and are an indication for coronary angiography. Patients with a low risk of complications may be candidates for early discharge. The lowest-risk patients are those who did not have STEMI despite the initial suspicions. Clinicians should strive to identify such patients within 8 to 12 hours of onset of symptoms. Serial sampling of serum cardiac biomarkers and use of 12-lead ECGs and their interpretation in the context of the number of hours that have elapsed since onset of the patient's symptoms can determine the presence of STEMI better than adherence to a rigid protocol that requires that a specified number of samples be drawn in the hospital.

Medication Assessment

Beta-Blockers

Class I

1. Patients receiving beta-blockers within the first 24 hours of STEMI without adverse effects should continue to receive them during the early convalescent phase of STEMI. (Level of Evidence: A)
2. Patients without contraindications to beta-blockers who did not receive them within the first 24 hours after STEMI should have them started in the early convalescent phase. (Level of Evidence: A)
3. Patients with early contraindications within the first 24 hours of STEMI should be reevaluated for candidacy for beta-blocker therapy. (Level of Evidence: C)

Nitroglycerin

Class I

1. Intravenous nitroglycerin is indicated in the first 48 hours after STEMI for treatment of persistent ischemia, CHF, or hypertension. The decision to administer intravenous nitroglycerin and the dose used should not preclude therapy with other proven mortality reducing interventions, such as beta-blockers or ACE inhibitors. (Level of Evidence: B)
2. Intravenous, oral, or topical nitrates are useful beyond the first 48 hours after STEMI for treatment of recurrent angina or persistent CHF if their use does not preclude therapy with beta-blockers or ACE inhibitors. (Level of Evidence: B)

Class IIb

1. The continued use of nitrate therapy beyond the first 24 to 48 hours in the absence of continued or recurrent angina or CHF may be helpful, although the benefit is likely to be small and is not well established in contemporary practice. (Level of Evidence: B)

Class III

1. Nitrates should not be administered to patients with systolic pressure less than 90 mm Hg or greater than or equal to 30 mm Hg below baseline, severe bradycardia (less than 50 bpm), tachycardia (more than 100 bpm), or RV infarction. (Level of Evidence: C)

Inhibition of the Renin-Angiotensin - Aldosterone System

Class I

1. An ACE inhibitor should be administered orally during convalescence from STEMI in patients who tolerate this class of medication, and it should be continued over the long term. (Level of Evidence: A)
2. An ARB should be administered to STEMI patients who are intolerant of ACE inhibitors and have either clinical or radiological signs of heart failure or LVEF less than 0.40. Valsartan and candesartan have demonstrated efficacy for this recommendation. (Level of Evidence: B)
3. Long-term aldosterone blockade should be prescribed for post-STEMI patients without significant renal dysfunction (creatinine should be less than or equal to 2.5 mg/dL in men and less than or equal to 2.0 mg/dL in women) or hyperkalemia (potassium should be less than or equal to 5.0 mEq/L) who are already receiving therapeutic doses of an ACE inhibitor, have an LVEF less than or equal to 0.40, and have either symptomatic heart failure or diabetes. (Level of Evidence: A)

Class IIa

1. In STEMI patients who tolerate ACE inhibitors, an ARB can be useful as an alternative to ACE inhibitors provided there are either clinical or radiological signs of heart failure or LVEF is less than 0.40. Valsartan and candesartan have established efficacy for this recommendation. (Level of Evidence: B)

Antiplatelets

Class I

1. Aspirin 162 to 325 mg should be given on day 1 of STEMI and in the absence of contraindications should be continued indefinitely on a daily basis thereafter at a dose of 75 to 162 mg. (Level of Evidence: A)
2. A thienopyridine (preferably clopidogrel) should be administered to patients who are unable to take aspirin because of hypersensitivity or major gastrointestinal intolerance. (Level of Evidence: C)
3. For patients taking clopidogrel for whom CABG is planned, if possible, the drug should be withheld for at least 5 days, and preferably for 7, unless the

- urgency for revascularization outweighs the risks of bleeding. (Level of Evidence: B)
4. For patients who have undergone diagnostic cardiac catheterization and for whom PCI is planned, clopidogrel should be started and continued for at least 1 month after bare metal stent implantation and for several months after drug-eluting stent implantation (3 months for sirolimus, 6 months for paclitaxel) and up to 12 months in patients who are not at high risk for bleeding. (Level of Evidence: B)

Antithrombotics

Class I

1. Intravenous UFH (bolus of 60 U/kg, maximum 4,000 U IV; initial infusion 12 U/kg per hour, maximum of 1,000 U/h) or LMWH should be used in patients after STEMI who are at high risk for systemic emboli (large or anterior MI, atrial fibrillation, previous embolus, known LV thrombus, or cardiogenic shock). (Level of Evidence: C)

Class IIa

1. It is reasonable that STEMI patients not undergoing reperfusion therapy who do not have a contraindication to anticoagulation be treated with intravenous or subcutaneous UFH or with subcutaneous LMWH for at least 48 hours. In patients whose clinical condition necessitates prolonged bed rest and/or minimized activities, it is reasonable that treatment be continued until the patient is ambulatory. (Level of Evidence: C)

Class IIb

1. Prophylaxis for deep venous thrombosis (DVT) with subcutaneous LMWH (dosed appropriately for specific agent) or with subcutaneous UFH, 7,500 U to 12,500 U twice per day until completely ambulatory, may be useful, but the effectiveness of such a strategy is not well established in the contemporary era of routine aspirin use and early mobilization. (Level of Evidence: C)

Oxygen

Class I

1. Supplemental oxygen therapy should be continued beyond the first 6 hours in STEMI patients with arterial oxygen desaturation (SaO_2 less than 90%) or overt pulmonary congestion. (Level of Evidence: C)

Estimation of Infarct Size

Measurement of infarct size is an important element in the overall care of patients with STEMI. There are 5 major modalities that can be applied to sizing MI.

Electrocardiographic Techniques

Class I

1. All patients with STEMI should have follow-up ECGs at 24 hours and at hospital discharge to assess the success of reperfusion and/or the extent of infarction, defined in part by the presence or absence of new Q waves. (Level of Evidence: B)

Cardiac Biomarker Methods

The most widely accepted method for quantifying infarction has been the use of serial creatine kinase and the creatine kinase-MB isoenzyme.

Radionuclide Imaging

The most comprehensive assessment of STEMI with radionuclide imaging was developed with the technetium sestamibi SPECT approach. This approach is well delineated in the ACC/AHA/ASNC Guidelines for the Clinical Use of Cardiac Radionuclide Imaging.

Echocardiography

Global and regional LV function provides an assessment of the functional consequences of STEMI and ischemia. Readers are referred to the ACC/AHA/ASE 2003 Guideline Update for the Clinical Application of Echocardiography and to Section 7.11.1.2 of the full-text STEMI guidelines.

Magnetic Resonance Imaging (MRI)

Measurement of infarct size by MRI is a promising new technique that affords enhanced spatial resolution, thereby permitting more accurate assessment of both the transmural and circumferential extent of infarction. However, additional experience and comparison with other methods of assessing infarct size are required before any clinical recommendations can be provided.

Hemodynamic Disturbances

Hemodynamic Assessment

Class I

1. Pulmonary artery catheter monitoring should be performed for the following:
 - a. Progressive hypotension, when unresponsive to fluid administration or when fluid administration may be contraindicated. (Level of Evidence: C)
 - b. Suspected mechanical complications of STEMI, (i.e., VSR, papillary muscle rupture, or free wall rupture with pericardial tamponade) if an echocardiogram has not been performed. (Level of Evidence: C)
2. Intra-arterial pressure monitoring should be performed for the following:
 - a. Patients with severe hypotension (systolic arterial pressure less than 80 mm Hg). (Level of Evidence: C)
 - b. Patients receiving vasopressor/inotropic agents. (Level of Evidence: C)

- c. Cardiogenic shock. (Level of Evidence: C)

Class IIa

1. Pulmonary artery catheter monitoring can be useful for the following:
 - a. Hypotension in a patient without pulmonary congestion who has not responded to an initial trial of fluid administration. (Level of Evidence: C)
 - b. Cardiogenic shock. (Level of Evidence: C)
 - c. Severe or progressive CHF or pulmonary edema that does not respond rapidly to therapy. (Level of Evidence: C)
 - d. Persistent signs of hypoperfusion without hypotension or pulmonary congestion. (Level of Evidence: C)
 - e. Patients receiving vasopressor/inotropic agents. (Level of Evidence: C)
2. Intra-arterial pressure monitoring can be useful for patients receiving intravenous sodium nitroprusside or other potent vasodilators. (Level of Evidence: C)

Class IIb

1. Intra-arterial pressure monitoring might be considered in patients receiving intravenous inotropic agents. (Level of Evidence: C)

Class III

1. Pulmonary artery catheter monitoring is not recommended in patients with STEMI without evidence of hemodynamic instability or respiratory compromise. (Level of Evidence: C)
2. Intra-arterial pressure monitoring is not recommended for patients with STEMI who have no pulmonary congestion and have adequate tissue perfusion without use of circulatory support measures. (Level of Evidence: C)

Hypotension

Class I

1. Rapid volume loading with an IV infusion should be administered to patients without clinical evidence for volume overload. (Level of Evidence: C)
2. Rhythm disturbances or conduction abnormalities causing hypotension should be corrected. (Level of Evidence: C)
3. Intra-aortic balloon counterpulsation should be performed in patients who do not respond to other interventions, unless further support is futile because of the patient's wishes or contraindications/unsuitability for further invasive care. (Level of Evidence: B)
4. Vasopressor support should be given for hypotension that does not resolve after volume loading. (Level of Evidence: C)
5. Echocardiography should be used to evaluate mechanical complications unless these are assessed by invasive measures. (Level of Evidence: C)

Low-Output State

Class I

1. LV function and potential presence of a mechanical complication should be assessed by echocardiography if these have not been evaluated by invasive measures. (Level of Evidence: C)
2. Recommended treatments for low-output states include:
 - a. Inotropic support. (Level of Evidence: B)
 - b. Intra-aortic counterpulsation. (Level of Evidence: B)
 - c. Mechanical reperfusion with PCI or CABG. (Level of Evidence: B)
 - d. Surgical correction of mechanical complications. (Level of Evidence: B)

Class III

1. Beta-blockers or calcium channel antagonists should not be administered to patients in a low-output state due to pump failure. (Level of Evidence: B)

Pulmonary Congestion

Class I

1. Oxygen supplementation to arterial saturation greater than 90% is recommended for patients with pulmonary congestion. (Level of Evidence: C)
2. Morphine sulfate should be given to patients with pulmonary congestion. (Level of Evidence: C)
3. ACE inhibitors, beginning with titration of a short-acting ACE inhibitor with a low initial dose (e.g., 1 to 6.25 mg of captopril) should be given to patients with pulmonary edema unless the systolic blood pressure is less than 100 mm Hg or more than 30 mm Hg below baseline. Patients with pulmonary congestion and marginal or low blood pressure often need circulatory support with inotropic and vasopressor agents and/or intra-aortic balloon counterpulsation to relieve pulmonary congestion and maintain adequate perfusion. (Level of Evidence: A)
4. Nitrates should be administered to patients with pulmonary congestion unless the systolic blood pressure is less than 100 mm Hg or more than 30 mm Hg below baseline. Patients with pulmonary congestion and marginal or low blood pressure often need circulatory support with inotropic and vasopressor agents and/or intra-aortic balloon counterpulsation to relieve pulmonary congestion and maintain adequate perfusion. (Level of Evidence: C)
5. A diuretic (low- to intermediate-dose furosemide, or torsemide or bumetanide) should be administered to patients with pulmonary congestion if there is associated volume overload. Caution is advised for patients who have not received volume expansion. (Level of Evidence: C)
6. Beta-blockade should be initiated before discharge for secondary prevention. For those who remain in heart failure throughout the hospitalization, low doses should be initiated, with gradual titration on an outpatient basis. (Level of Evidence: B)
7. Long-term aldosterone blockade should be prescribed for post-STEMI patients without significant renal dysfunction (creatinine should be less than or equal to 2.5 mg/dL in men and less than or equal to 2.0 mg/dL in women) or hyperkalemia (potassium should be less than or equal to 5.0 mEq/L) who are already receiving therapeutic doses of an ACE inhibitor, have an LVEF less

than or equal to 0.40, and have either symptomatic heart failure or diabetes. (Level of Evidence: A)

8. Echocardiography should be performed urgently to estimate LV and RV function and to exclude a mechanical complication. (Level of Evidence: C)

Class IIb

1. It may be reasonable to insert an intra-aortic balloon pump (IABP) for the management of patients with refractory pulmonary congestion. (Level of Evidence: C)

Class III

1. Beta-blockers or calcium channel blockers should not be administered acutely to STEMI patients with frank cardiac failure evidenced by pulmonary congestion or signs of a low-output state. (Level of Evidence: B)

Cardiogenic Shock

Class I

1. Intra-aortic balloon counterpulsation is recommended for STEMI patients when cardiogenic shock is not quickly reversed with pharmacological therapy. The IABP is a stabilizing measure for angiography and prompt revascularization. (Level of Evidence: B)
2. Intra-arterial monitoring is recommended for the management of STEMI patients with cardiogenic shock. (Level of Evidence: C)
3. Early revascularization, either PCI or CABG, is recommended for patients less than 75 years old with ST elevation or LBBB who develop shock within 36 hours of MI and are suitable for revascularization that can be performed within 18 hours of shock, unless further support is futile because of the patient's wishes or contraindications/unsuitability for further invasive care. (Level of Evidence: A)
4. Fibrinolytic therapy should be administered to STEMI patients with cardiogenic shock who are unsuitable for further invasive care and do not have contraindications to fibrinolysis. (Level of Evidence: B)
5. Echocardiography should be used to evaluate mechanical complications unless these are assessed by invasive measures. (Level of Evidence: C)

Class IIa

1. Pulmonary artery catheter monitoring can be useful for the management of STEMI patients with cardiogenic shock. (Level of Evidence: C)
2. Early revascularization, either PCI or CABG, is reasonable for selected patients 75 years or older with ST elevation or LBBB who develop shock within 36 hours of MI and are suitable for revascularization that can be performed within 18 hours of shock. Patients with good prior functional status who agree to invasive care may be selected for such an invasive strategy. (Level of Evidence: B)

Right Ventricular Infarction

Class I

1. Patients with inferior STEMI and hemodynamic compromise should be assessed with a right precordial V₄R lead to detect ST-segment elevation and an echocardiogram to screen for RV infarction. (See the ACC/AHA/ASE 2003 Guideline Update for the Clinical Application of Echocardiography.) (Level of Evidence: B)
2. The following principles apply to therapy of patients with STEMI and RV infarction and ischemic dysfunction:
 - a. Early reperfusion should be achieved if possible. (Level of Evidence: C)
 - b. AV synchrony should be achieved, and bradycardia should be corrected. (Level of Evidence: C)
 - c. RV preload should be optimized, which usually requires initial volume challenge in patients with hemodynamic instability provided the jugular venous pressure is normal or low. (Level of Evidence: C)
 - d. RV afterload should be optimized, which usually requires therapy for concomitant LV dysfunction. (Level of Evidence: C)
 - e. Inotropic support should be used for hemodynamic instability not responsive to volume challenge. (Level of Evidence: C)

Class IIa

1. After infarction that leads to clinically significant RV dysfunction, it is reasonable to delay CABG surgery for 4 weeks to allow recovery of contractile performance. (Level of Evidence: C)

Mechanical Causes of Heart Failure/Low-Output Syndrome

Diagnosis

On physical examination, the presence of a new cardiac murmur indicates the possibility of either a VSR or MR. A precise diagnosis can usually be established with transthoracic or transesophageal echocardiography.

Mitral Valve Regurgitation

Class I

1. Patients with acute papillary muscle rupture should be considered for urgent cardiac surgical repair, unless further support is considered futile because of the patient's wishes or contraindications/unsuitability for further invasive care. (Level of Evidence: B)
2. CABG surgery should be undertaken at the same time as mitral valve surgery. (Level of Evidence: B)

The patient should be stabilized with an IABP, inotropic support, and afterload reduction (to reduce regurgitant volume and pulmonary congestion) while emergency surgery is arranged.

Ventricular Septal Rupture After STEMI

Class I

1. Patients with STEMI complicated by the development of a VSR should be considered for urgent cardiac surgical repair, unless further support is considered futile because of the patient's wishes or contraindications/unsuitability for further invasive care. (Level of Evidence: B)
2. CABG should be undertaken at the same time as repair of the VSR. (Level of Evidence: B)

Insertion of an IABP and prompt surgical referral are recommended for almost every patient with an acute VSR. Invasive monitoring is recommended in all patients, together with judicious use of inotropes and a vasodilator to maintain optimal hemodynamics. Surgical repair usually involves excision of all necrotic tissue and patch repair of the VSR, together with coronary artery grafting.

Left Ventricular Free-Wall Rupture

Class I

1. Patients with free-wall rupture should be considered for urgent cardiac surgical repair, unless further support is considered futile because of the patient's wishes or contraindications/unsuitability for further invasive care. (Level of Evidence: B)
2. CABG should be undertaken at the same time as repair of free-wall rupture. (Level of Evidence: C)

Surgery includes repair of the ventricle by a direct suture technique or patch to cover the ventricular perforation in addition to CABG as needed.

Left Ventricular Aneurysm

Class IIa

1. It is reasonable that patients with STEMI who develop a ventricular aneurysm associated with intractable ventricular tachyarrhythmias and/or pump failure unresponsive to medical and catheter-based therapy be considered for LV aneurysmectomy and CABG surgery. (Level of Evidence: B)

Mechanical Support of the Failing Heart

- Intra-Aortic Balloon Counterpulsation

Class I

1. Intra-aortic balloon counterpulsation should be used in STEMI patients with hypotension (systolic blood pressure less than 90 mm Hg or 30 mm Hg below baseline mean arterial pressure) who do not respond to other interventions, unless further support is futile because of the patient's wishes or contraindications/unsuitability for further invasive care. See Section 7.6.2 of the full-text guidelines. (Level of Evidence: B)

2. Intra-aortic balloon counterpulsation is recommended for STEMI patients with low-output state. See Section 7.6.3 of the full-text guidelines. (Level of Evidence: B)
3. Intra-aortic balloon counterpulsation is recommended for STEMI patients when cardiogenic shock is not quickly reversed with pharmacological therapy. IABP is a stabilizing measure for angiography and prompt revascularization. See Section 7.6.5 of the full-text guidelines. (Level of Evidence: B)
4. Intra-aortic balloon counterpulsation should be used in addition to medical therapy for STEMI patients with recurrent ischemic-type chest discomfort and signs of hemodynamic instability, poor LV function, or a large area of myocardium at risk. Such patients should be referred urgently for cardiac catheterization and should undergo revascularization as needed. See Section 7.8.2 of the full-text guidelines. (Level of Evidence: C)

Class II a

1. It is reasonable to manage STEMI patients with refractory polymorphic VT with intra-aortic balloon counterpulsation to reduce myocardial ischemia. See Section 7.7.1.2 of the full-text guidelines. (Level of Evidence: B)

Class II b

1. It may be reasonable to use intra-aortic balloon counterpulsation in the management of STEMI patients with refractory pulmonary congestion. See Section 7.6.4 of the full-text guidelines. (Level of Evidence: C)

Selected patients with cardiogenic shock after STEMI, especially if not candidates for revascularization, may be considered for either a short- or long-term mechanical support device to serve as a bridge to recovery or to subsequent cardiac transplantation.

Arrhythmias after STEMI

Ventricular Arrhythmias

Ventricular Fibrillation

Class I

1. Ventricular fibrillation (VF) or pulseless VT should be treated with an unsynchronized electric shock with an initial monophasic shock energy of 200 J; if unsuccessful, a second shock of 200 to 300 J should be given, and then, if necessary, a third shock of 360 J. (Level of Evidence: B)

Class II a

1. It is reasonable that VF or pulseless VT that is refractory to electrical shock be treated with amiodarone (300 mg or 5 mg/kg, IV bolus) followed by a repeat unsynchronized electric shock. (Level of Evidence: B)
2. It is reasonable to correct electrolyte and acid-base disturbances (potassium greater than 4.0 mEq/L and magnesium greater than 2.0 mg/dL) to prevent recurrent episodes of VF once an initial episode of VF has been treated. (Level of Evidence: C)

Class IIb

1. It may be reasonable to treat VT or shock-refractory VF with boluses of intravenous procainamide. However, this has limited value owing to the length of time required for administration. (Level of Evidence: C)

Class III

1. Prophylactic administration of antiarrhythmic therapy is not recommended when using fibrinolytic agents. (Level of Evidence: B)

Ventricular Tachycardia

Class I

1. Sustained (more than 30 seconds or causing hemodynamic collapse) polymorphic VT should be treated with an unsynchronized electric shock with an initial monophasic shock energy of 200 J; if unsuccessful, a second shock of 200 to 300 J should be given, and, if necessary, a third shock of 360 J. (Level of Evidence: B)
2. Episodes of sustained monomorphic VT associated with angina, pulmonary edema, or hypotension (blood pressure less than 90 mm Hg) should be treated with a synchronized electric shock of 100 J initial monophasic shock energy. Increasing energies may be used if not initially successful. Brief anesthesia is desirable if hemodynamically tolerable. (Level of Evidence: B)
3. Sustained monomorphic VT not associated with angina, pulmonary edema, or hypotension (blood pressure less than 90 mm Hg) should be treated with:
 - a. Amiodarone: 150 mg infused over 10 minutes (alternative dose 5 mg/kg); repeat 150 mg every 10 to 15 minutes as needed. Alternative infusion: 360 mg over 6 hours (1 mg/min), then 540 mg over the next 18 hours (0.5 mg/min). The total cumulative dose, including additional doses given during cardiac arrest, must not exceed 2.2 g over 24 hours. (Level of Evidence: B)
 - b. Synchronized electrical cardioversion starting at monophasic energies of 50 J (brief anesthesia is necessary). (Level of Evidence: B)

Class IIa

1. It is reasonable to manage refractory polymorphic VT by:
 - a. Aggressive attempts to reduce myocardial ischemia and adrenergic stimulation, including therapies such as beta-adrenoceptor blockade, IABP use, and consideration of emergency PCI/CABG surgery (Level of Evidence: B)

- b. Aggressive normalization of serum potassium to greater than 4.0 mEq/L and of magnesium to greater than 2.0 mg/dL (Level of Evidence: C)
- c. If the patient has bradycardia to a rate less than 60 beats per minute or long QTc, temporary pacing at a higher rate may be instituted. (Level of Evidence: C)

Class IIb

- 1. It may be useful to treat sustained monomorphic VT not associated with angina, pulmonary edema, or hypotension (blood pressure less than 90 mm Hg) with a procainamide bolus and infusion. (Level of Evidence: C)

Class III

- 1. The routine use of prophylactic antiarrhythmic drugs (i.e., lidocaine) is not indicated for suppression of isolated ventricular premature beats, couplets, runs of accelerated idioventricular rhythm, or nonsustained VT. (Level of Evidence: B)
- 2. The routine use of prophylactic antiarrhythmic therapy is not indicated when fibrinolytic agents are administered. (Level of Evidence: B)

Ventricular Premature Beats

Class III

- 1. Treatment of isolated ventricular premature beats, couplets, and nonsustained VT is not recommended unless they lead to hemodynamic compromise. (Level of Evidence: A)

Accelerated Idioventricular Rhythms and Accelerated Junctional Rhythms

Class III

- 1. Antiarrhythmic therapy is not indicated for accelerated idioventricular rhythm. (Level of Evidence: C)
- 2. Antiarrhythmic therapy is not indicated for accelerated junctional rhythm. (Level of Evidence: C)

Implantable Cardioverter Defibrillator Implantation in Patients After STEMI

Class I

- 1. An implantable cardioverter-defibrillator (ICD) is indicated for patients with VF or hemodynamically significant sustained VT more than 2 days after STEMI, provided the arrhythmia is not judged to be due to transient or reversible ischemia or reinfarction. (Level of Evidence: A)
- 2. An ICD is indicated for patients without spontaneous VF or sustained VT more than 48 hours after STEMI whose STEMI occurred at least 1 month previously, who have an LVEF between 0.31 and 0.40, demonstrate additional

evidence of electrical instability (e.g., nonsustained VT), and have inducible VF or sustained VT on electrophysiological testing. (Level of Evidence: B)

Class IIa

1. If there is reduced LVEF (0.30 or less) at least 1 month after STEMI and 3 months after coronary artery revascularization, it is reasonable to implant an ICD in post STEMI patients without spontaneous VF or sustained VT more than 48 hours after STEMI. (Level of Evidence: B)

Class IIb

1. The usefulness of an ICD is not well established in STEMI patients without spontaneous VF or sustained VT more than 48 hours after STEMI who have a reduced LVEF (0.31 to 0.40) at least 1 month after STEMI but who have no additional evidence of electrical instability (e.g., nonsustained VT). (Level of Evidence: B)
2. The usefulness of an ICD is not well established in STEMI patients without spontaneous VF or sustained VT more than 48 hours after STEMI who have a reduced LVEF (0.31 to 0.40) at least 1 month after STEMI and additional evidence of electrical instability (e.g., nonsustained VT) but who do not have inducible VF or sustained VT on electrophysiological testing. (Level of Evidence: B)

Class III

1. An ICD is not indicated in STEMI patients who do not experience spontaneous VF or sustained VT more than 48 hours after STEMI and in whom the LVEF is greater than 0.40 at least 1 month after STEMI. (Level of Evidence: C)

See the full-text guidelines for discussion.

Supraventricular Arrhythmias/Atrial Fibrillation

Class I

1. Sustained atrial fibrillation and atrial flutter in patients with hemodynamic compromise or ongoing ischemia should be treated with one or more of the following:
 - a. Synchronized cardioversion with an initial monophasic shock of 200 J for atrial fibrillation and 50 J for flutter, preceded by brief general anesthesia or conscious sedation whenever possible. (Level of Evidence: C)
 - b. For episodes of atrial fibrillation that do not respond to electrical cardioversion or recur after a brief period of sinus rhythm, the use of antiarrhythmic therapy aimed at slowing the ventricular response is indicated. One or more of these pharmacological agents may be used:
 - i. Intravenous amiodarone. (Level of Evidence: C)
 - ii. Intravenous digoxin for rate control principally for patients with severe LV dysfunction and heart failure. (Level of Evidence: C)

2. Sustained atrial fibrillation and atrial flutter in patients with ongoing ischemia but without hemodynamic compromise should be treated with one or more of the following:
 - a. Beta-adrenergic blockade is preferred, unless contraindicated. (Level of Evidence: C)
 - b. Intravenous diltiazem or verapamil. (Level of Evidence: C)
 - c. Synchronized cardioversion with an initial monophasic shock of 200 J for atrial fibrillation and 50 J for flutter, preceded by brief general anesthesia or conscious sedation whenever possible. (Level of Evidence: C)
3. For episodes of sustained atrial fibrillation or flutter without hemodynamic compromise or ischemia, rate control is indicated. In addition, patients with sustained atrial fibrillation or flutter should be given anticoagulant therapy. Consideration should be given to cardioversion to sinus rhythm in patients with a history of atrial fibrillation or flutter prior to STEMI. (Level of Evidence: C)
4. Reentrant paroxysmal supraventricular tachycardia, because of its rapid rate, should be treated with the following in the sequence shown:
 - a. Carotid sinus massage (Level of Evidence: C)
 - b. Intravenous adenosine (6 mg X 1 over 1 to 2 seconds; if no response, 12 mg IV after 1 to 2 minutes may be given; repeat 12 mg dose if needed (Level of Evidence: C)
 - c. Intravenous beta-adrenergic blockade with metoprolol (2.5 to 5.0 mg every 2 to 5 minutes to a total of 15 mg over 10 to 15 minutes) or atenolol (2.5 to 5.0 mg over 2 minutes to a total of 10 mg in 10 to 15 minutes) (Level of Evidence: C)
 - d. Intravenous diltiazem (20 mg [0.25 mg/kg]) over 2 minutes followed by an infusion of 10 mg/h) (Level of Evidence: C)
 - e. Intravenous digoxin, recognizing that there may be a delay of at least 1 hour before pharmacological effects appear (8 to 15 micrograms/kg [0.6 to 1.0 mg in a person weighing 70 kg]). (Level of Evidence: C)

Class III

1. Treatment of atrial premature beats is not indicated. (Level of Evidence: C)

See the full-text guidelines for discussion.

Bradyarrhythmias

Acute Treatment of Conduction Disturbances and Bradyarrhythmias

- Ventricular Asystole

Class I

1. Prompt resuscitative measures, including chest compressions, atropine, vasopressin, epinephrine, and temporary pacing, should be administered to treat ventricular asystole. (Level of Evidence: B)

Use of Permanent Pacemakers

- Permanent Pacing for Bradycardia or Conduction Blocks Associated with STEMI

Class I

1. Permanent ventricular pacing is indicated for persistent second-degree AV block in the His-Purkinje system with bilateral bundle-branch block or third-degree AV block within or below the His-Purkinje system after STEMI. (Level of Evidence: B)
2. Permanent ventricular pacing is indicated for transient advanced second- or third-degree infranodal AV block and associated bundle-branch block. If the site of block is uncertain, an electrophysiological study may be necessary. (Level of Evidence: B)
3. Permanent ventricular pacing is indicated for persistent and symptomatic second- or third-degree AV block. (Level of Evidence: C)

Class IIb

1. Permanent ventricular pacing may be considered for persistent second- or third-degree AV block at the AV node level. (Level of Evidence: B)

Class III

1. Permanent ventricular pacing is not recommended for transient AV block in the absence of intraventricular conduction defects. (Level of Evidence: B)
2. Permanent ventricular pacing is not recommended for transient AV block in the presence of isolated left anterior fascicular block. (Level of Evidence: B)
3. Permanent ventricular pacing is not recommended for acquired left anterior fascicular block in the absence of AV block. (Level of Evidence: B)
4. Permanent ventricular pacing is not recommended for persistent first-degree AV block in the presence of bundle-branch block that is old or of indeterminate age. (Level of Evidence: B)

Indications for permanent pacing after STEMI in patients experiencing AV block are related in large measure to the presence of intraventricular conduction defects (see Table 3 in the Executive Summary of the original guideline document for recommendations for treatment of atrioventricular and intraventricular conduction disturbances during STEMI). Unlike some other indications for permanent pacing, the criteria for patients with STEMI and AV block do not necessarily depend on the presence of symptoms. Furthermore, the requirement for temporary pacing in STEMI does not by itself constitute an indication for permanent pacing.

- Sinus Node Dysfunction after STEMI

Class I

1. Symptomatic sinus bradycardia, sinus pauses greater than 3 seconds, or sinus bradycardia with a heart rate less than 40 bpm and associated hypotension or signs of systemic hemodynamic compromise should be treated with an intravenous bolus of atropine 0.6 to 1.0 mg. If bradycardia is persistent and maximal (2 mg) doses of atropine have been used, transcutaneous or transvenous (preferably atrial) temporary pacing should be instituted. (Level of Evidence: C)

The published ACC/AHA Guidelines for Implantation of Pacemakers should be used to guide therapy in STEMI patients with persistent sinus node dysfunction.

- Pacing Mode Selection in STEMI Patients

Class I

1. All patients who have an indication for permanent pacing after STEMI should be evaluated for ICD indications. (Level of Evidence: C)

Class IIa

1. It is reasonable to implant a permanent dual-chamber pacing system in STEMI patients who need permanent pacing and are in sinus rhythm. It is reasonable that patients in permanent atrial fibrillation or flutter receive a single chamber ventricular device. (Level of Evidence: C)
2. It is reasonable to evaluate all patients who have an indication for permanent pacing after STEMI for biventricular pacing (cardiac resynchronization therapy). (Level of Evidence: C)

When a permanent pacemaker is being considered for a post- STEMI patient, the clinician should address 2 additional questions regarding the patient: is there an indication for biventricular pacing, and is there an indication for ICD use? The algorithm to define whether an ICD is indicated is contained in Figure 5 in the Executive Summary of the original guideline document.

Recurrent Chest Pain After STEMI

Pericarditis

Class I

1. Aspirin is recommended for treatment of pericarditis after STEMI. Doses as high as 650 mg orally (enteric) every 4 to 6 hours may be needed. (Level of Evidence: B)
2. Anticoagulation should be immediately discontinued if pericardial effusion develops or increases. (Level of Evidence: C)

Class IIa

1. For episodes of pericarditis after STEMI that are not adequately controlled with aspirin, it is reasonable to administer 1 or more of the following:
 - a. Colchicine 0.6 mg every 12 hours orally (Level of Evidence: B)
 - b. Acetaminophen 500 mg orally every 6 hours (Level of Evidence: C)

Class IIb

1. Nonsteroidal anti-inflammatory drugs may be considered for pain relief; however, they should not be used for extended periods because of their continuous effect on platelet function, an increased risk of myocardial scar thinning, and infarct expansion. (Level of Evidence: B)
2. Corticosteroids might be considered only as a last resort in patients with pericarditis refractory to aspirin or nonsteroidal drugs. Although corticosteroids are effective for pain relief, their use is associated with an increased risk of scar thinning and myocardial rupture. (Level of Evidence: C)

Class III

1. Ibuprofen should not be used for pain relief because it blocks the antiplatelet effect of aspirin and can cause myocardial scar thinning and infarct expansion. (Level of Evidence: B)

Recurrent Ischemia/Infarction

Class I

1. Patients with recurrent ischemic-type chest discomfort after initial reperfusion therapy for STEMI should undergo escalation of medical therapy with nitrates and beta-blockers to decrease myocardial oxygen demand and reduce ischemia. Intravenous anticoagulation should be initiated if not already accomplished. (Level of Evidence: B)
2. In addition to escalation of medical therapy, patients with recurrent ischemic-type chest discomfort and signs of hemodynamic instability, poor LV function, or a large area of myocardium at risk should be referred urgently for cardiac catheterization and undergo revascularization as needed. Insertion of an IABP should also be considered. (Level of Evidence: C)
3. Patients with recurrent ischemic-type chest discomfort who are considered candidates for revascularization should undergo coronary arteriography and PCI or CABG as dictated by coronary anatomy. (Level of Evidence: B)

Class IIa

1. It is reasonable to (re)administer fibrinolytic therapy to patients with recurrent ST elevation and ischemic-type chest discomfort who are not considered candidates for revascularization or for whom coronary angiography and PCI cannot be rapidly (ideally within 60 minutes from the onset of recurrent discomfort) implemented. (Level of Evidence: C)

Class III

1. Streptokinase should not be readministered to treat recurrent ischemia/infarction in patients who received a non-fibrin-specific fibrinolytic agent more than 5 days previously to treat the acute STEMI event. (Level of Evidence: C)

Patients with recurrent ischemic-type chest discomfort should undergo escalation of medical therapy that includes beta-blockers (intravenously and then orally) and nitrates (sublingually and then intravenously); consideration should be given to initiation of intravenous anticoagulation if the patient is not already therapeutically anticoagulated. Secondary causes of recurrent ischemia, such as poorly controlled heart failure, anemia, and arrhythmias, should be corrected.

Other Complications

Ischemic Stroke

Class I

1. Neurological consultation should be obtained in STEMI patients who have an acute ischemic stroke. (Level of Evidence: C)
2. STEMI patients who have an acute ischemic stroke should be evaluated with echocardiography, neuroimaging, and vascular imaging studies to determine the cause of the stroke. (Level of Evidence: C)
3. STEMI patients with acute ischemic stroke and persistent atrial fibrillation should receive lifelong moderate intensity (international normalized ratio [INR] 2 to 3) warfarin therapy. (Level of Evidence: A)
4. STEMI patients with or without acute ischemic stroke who have a cardiac source of embolism (atrial fibrillation, mural thrombus, or akinetic segment) should receive moderate-intensity (INR 2 to 3) warfarin therapy (in addition to aspirin). The duration of warfarin therapy should be dictated by clinical circumstances (e.g., at least 3 months for patients with an LV mural thrombus or akinetic segment and indefinitely in patients with persistent atrial fibrillation). The patient should receive LMWH or UFH until adequately anticoagulated with warfarin. (Level of Evidence: B)

Class IIa

1. It is reasonable to assess the risk of ischemic stroke in patients with STEMI. (Level of Evidence: A)
2. It is reasonable that STEMI patients with nonfatal acute ischemic stroke receive supportive care to minimize complications and maximize functional outcome. (Level of Evidence: C)

Class IIb

1. Carotid angioplasty/stenting, 4 to 6 weeks after ischemic stroke, might be considered in STEMI patients who have an acute ischemic stroke attributable to an internal carotid artery-origin stenosis of at least 50% and who have a high surgical risk of morbidity/mortality early after STEMI. (Level of Evidence: C)

An algorithm for evaluation and antithrombotic therapy for ischemic stroke is shown in Figure 35 of the original full-text guideline.

DVT and Pulmonary Embolism

Class I

1. DVT or pulmonary embolism after STEMI should be treated with full-dose LMWH for a minimum of 5 days and until the patient is adequately anticoagulated with warfarin. Start warfarin concurrently with LMWH and titrate to INR of 2 to 3. (Level of Evidence: A)
2. Patients with CHF after STEMI who are hospitalized for prolonged periods, unable to ambulate, or considered at high risk for DVT and are not otherwise anticoagulated should receive low-dose heparin prophylaxis, preferably with LMWH. (Level of Evidence: A)

CABG Surgery After STEMI

Timing of Surgery

Class IIa

1. In patients who have had a STEMI, CABG mortality is elevated for the first 3 to 7 days after infarction, and the benefit of revascularization must be balanced against this increased risk. Patients who have been stabilized (no ongoing ischemia, hemodynamic compromise, or life-threatening arrhythmia) after STEMI and who have incurred a significant fall in LV function should have their surgery delayed to allow myocardial recovery to occur. If critical anatomy exists, revascularization should be undertaken during the index hospitalization. (Level of Evidence: B)

The Writing Committee believes that if stable STEMI patients with preserved LV function require surgical revascularization, then CABG can be undertaken within several days of the infarction without an increased risk.

Arterial Grafting

Class I

1. An internal mammary artery graft to a significantly stenosed left anterior descending coronary artery should be used whenever possible in patients undergoing CABG after STEMI. (Level of Evidence: B)

CABG for Recurrent Ischemia after STEMI

Class I

1. Urgent CABG is indicated if the coronary angiogram reveals anatomy that is unsuitable for PCI. (Level of Evidence: B)

Elective CABG Surgery after STEMI in Patients with Angina

Class I

1. CABG is recommended for patients with stable angina who have significant left main coronary artery stenosis. (Level of Evidence: A)
2. CABG is recommended for patients with stable angina who have left main equivalent disease: significant (at least 70%) stenosis of the proximal left anterior descending coronary artery and proximal left circumflex artery. (Level of Evidence: A)
3. CABG is recommended for patients with stable angina who have 3-vessel disease. (Survival benefit is greater when LVEF is less than 0.50.) (Level of Evidence: A)
4. CABG is beneficial for patients with stable angina who have 1- or 2-vessel coronary disease without significant proximal left anterior descending coronary artery stenosis but with a large area of viable myocardium and high-risk criteria on noninvasive testing. (Level of Evidence: B)
5. CABG is recommended in patients with stable angina who have 2-vessel disease with significant proximal left anterior descending coronary artery stenosis and either ejection fraction less than 0.50 or demonstrable ischemia on noninvasive testing. (Level of Evidence: A)

The role of surgical revascularization has been reviewed extensively in the ACC/AHA Guidelines for CABG Surgery. Consideration for revascularization after STEMI includes PCI and CABG. Providers should individualize patient management on the basis of clinical circumstances, available revascularization options, and patient preference.

CABG Surgery after STEMI and Antiplatelet Agents

Class I

1. Aspirin should not be withheld before elective or nonelective CABG after STEMI. (Level of Evidence: C)
2. Aspirin (75 to 325 mg daily) should be prescribed as soon as possible (within 24 hours) after CABG unless contraindicated. (Level of Evidence: B)
3. In patients taking clopidogrel in whom elective CABG is planned, the drug should be withheld for 5 to 7 days. (Level of Evidence: B)

Convalescence, Discharge, and Post-MI Care

Risk Stratification at Hospital Discharge

The risk stratification approach for decision-making about catheterization is described in Figure 6 in the original guideline document's Executive Summary. The suggested algorithm for electrophysiological testing and ICD placement is shown in Figure 5 of that document.

Role of Exercise Testing

Class I

1. Exercise testing should be performed either in the hospital or early after discharge in STEMI patients not selected for cardiac catheterization and without high-risk features to assess the presence and extent of inducible ischemia. (Level of Evidence: B)
2. In patients with baseline abnormalities that compromise ECG interpretation, echocardiography or myocardial perfusion imaging should be added to standard exercise testing. (Level of Evidence: B)

Class IIb

1. Exercise testing might be considered before discharge of patients recovering from STEMI to guide the post-discharge exercise prescription or to evaluate the functional significance of a coronary lesion previously identified at angiography. (Level of Evidence: C)

Class III

1. Exercise testing should not be performed within 2 to 3 days of STEMI in patients who have not undergone successful reperfusion. (Level of Evidence: C)
2. Exercise testing should not be performed to evaluate patients with STEMI who have unstable postinfarction angina, decompensated CHF, life-threatening cardiac arrhythmias, noncardiac conditions that severely limit their ability to exercise, or other absolute contraindications to exercise testing. (Level of Evidence: C)
3. Exercise testing should not be used for risk stratification in patients with STEMI who have already been selected for cardiac catheterization. (Level of Evidence: C)

Exercise testing after STEMI may be performed to (1) assess functional capacity and the patient's ability to perform tasks at home and at work; (2) establish exercise parameters for cardiac rehabilitation; (3) evaluate the efficacy of the patient's current medical regimen; (4) risk-stratify the post- STEMI patient according to the likelihood of a subsequent cardiac event; (5) evaluate chest pain symptoms after STEMI; and (6) provide reassurance to patients regarding their functional capacity after STEMI as a guide to returning to work.

Role of Echocardiography

Noninvasive imaging in patients recovering from STEMI includes echocardiography and radionuclide imaging. This section discusses the role of echocardiography. (See Sections 7.11.1.3, 7.11.1.4, and 7.11.1.5 of the full-text guidelines for additional discussion on imaging considerations.)

Class I

1. Echocardiography should be used in patients with STEMI not undergoing LV angiography to assess baseline LV function, especially if the patient is hemodynamically unstable. (Level of Evidence: C)

2. Echocardiography should be used to evaluate patients with inferior STEMI, clinical instability, and clinical suspicion of RV infarction. (See ACC/AHA Guidelines for Clinical Application of Echocardiography) (Level of Evidence: C)
3. Echocardiography should be used in patients with STEMI to evaluate suspected complications, including acute MR, cardiogenic shock, infarct expansion, VSR, intracardiac thrombus, and pericardial effusion. (Level of Evidence: C)
4. Stress echocardiography (or myocardial perfusion imaging) should be used in patients with STEMI for in-hospital or early postdischarge assessment for inducible ischemia when baseline abnormalities are expected to compromise ECG interpretation. (Level of Evidence: C)

Class IIa

1. Echocardiography is reasonable in patients with STEMI to reevaluate ventricular function during recovery when results are used to guide therapy. (Level of Evidence: C)
2. Dobutamine echocardiography (or myocardial perfusion imaging) is reasonable in hemodynamically and electrically stable patients 4 or more days after STEMI to assess myocardial viability when required to define the potential efficacy of revascularization. (Level of Evidence: C)
3. In STEMI patients who have not undergone contrast ventriculography, echocardiography is reasonable to assess ventricular function after revascularization. (Level of Evidence: C)

Class III

1. Echocardiography should not be used for early routine reevaluation in patients with STEMI in the absence of any change in clinical status or revascularization procedure. Reassessment of LV function 30 to 90 days later may be reasonable. (Level of Evidence: C)

The use of echocardiography in STEMI is discussed in detail in the ACC/AHA/ASE 2003 Guideline Update for the Clinical Application of Echocardiography.

Exercise Myocardial Perfusion Imaging

Noninvasive imaging in patients recovering from STEMI includes echocardiography and radionuclide imaging. This section discusses the role of exercise myocardial perfusion imaging. (See Sections 7.11.1.2, 7.11.1.4, and 7.11.1.5 of the full-text guidelines for additional discussion on imaging considerations.)

Class I

1. Dipyridamole or adenosine stress perfusion nuclear scintigraphy or dobutamine echocardiography before or early after discharge should be used in patients with STEMI who are not undergoing cardiac catheterization to look for inducible ischemia in patients judged to be unable to exercise. (Level of Evidence: B)

Class IIa

1. Myocardial perfusion imaging or dobutamine echocardiography is reasonable in hemodynamically and electrically stable patients 4 to 10 days after STEMI to assess myocardial viability when required to define the potential efficacy of revascularization. (Level of Evidence: C)

Recommended strategies for exercise test evaluations after STEMI are presented in Figure 6 of the original guideline document's Executive Summary. These strategies and the data on which they are based are reviewed in more detail in the ACC/AHA 2002 Guideline Update for Exercise Testing.

LV Function

Noninvasive imaging in patients recovering from STEMI includes echocardiography and radionuclide imaging. This section discusses the importance of measurement of LV function. Either of the above imaging techniques can provide clinically useful information.

Class I

1. LVEF should be measured in all STEMI patients. (Level of Evidence: B)

Because of the dynamic nature of LV function recovery after STEMI, clinicians should consider the timing of the imaging study relative to the index event when assessing LV function. (See Table 6 of the ACC/AHA/ASE 2003 Guideline Update on the Clinical Application of Echocardiography for further discussion of the impact of timing on assessment of LV function and inducible ischemia.)

Invasive Evaluation

Class I

1. Coronary arteriography should be performed in patients with spontaneous episodes of myocardial ischemia or episodes of myocardial ischemia provoked by minimal exertion during recovery from STEMI. (Level of Evidence: A)
2. Coronary arteriography should be performed for intermediate- or high-risk findings on noninvasive testing after STEMI (see Table 23 of the ACC/AHA 2002 Guideline Update for the Management of Patients With Chronic Stable Angina). (Level of Evidence: B)
3. Coronary arteriography should be performed if the patient is sufficiently stable before definitive therapy of a mechanical complication of STEMI, such as acute MR, VSR, pseudoaneurysm, or LV aneurysm. (Level of Evidence: B)
4. Coronary arteriography should be performed in patients with persistent hemodynamic instability. (Level of Evidence: B)
5. Coronary arteriography should be performed in survivors of STEMI who had clinical heart failure during the acute episode but subsequently demonstrated well-preserved LV function. (Level of Evidence: C)

Class IIa

1. It is reasonable to perform coronary arteriography when STEMI is suspected to have occurred by a mechanism other than thrombotic occlusion of an

- atherosclerotic plaque. This would include coronary embolism, certain metabolic or hematological diseases, or coronary artery spasm. (Level of Evidence: C)
2. Coronary arteriography is reasonable in STEMI patients with any of the following: diabetes mellitus, LVEF less than 0.40, CHF, prior revascularization, or life-threatening ventricular arrhythmias. (Level of Evidence: C)

Class IIb

1. Catheterization and revascularization may be considered as part of a strategy of routine coronary arteriography for risk assessment after fibrinolytic therapy (See Section 6.3.1.6.4.7 of the full-text guidelines). (Level of Evidence: B)

Class III

1. Coronary arteriography should not be performed in survivors of STEMI who are thought not to be candidates for coronary revascularization. (Level of Evidence: A)

The Writing Committee encourages contemporary research into the benefit of routine catheterization versus watchful waiting after fibrinolytic therapy in the contemporary era. (See Section 6.3.1.6.4.7 of the full-text guidelines.)

Assessment of Ventricular Arrhythmias

Class IIb

1. Noninvasive assessment of the risk of ventricular arrhythmias may be considered (including signal-averaged ECG, 24-hour ambulatory monitoring, heart rate variability, micro T-wave alternans, and T-wave variability) in patients recovering from STEMI. (Level of Evidence: B)

The clinical applicability of these tests to the post-STEMI patient is in a state of evolution. Until these issues are resolved, use these tests are used only to support routine management and risk assessment.

Secondary Prevention

Class I

1. Patients who survive the acute phase of STEMI should have plans initiated for secondary prevention therapies. (Level of Evidence: A)

Secondary prevention therapies, unless contraindicated, are an essential part of the management of all patients with STEMI (see Table 4 of the original guideline document's Executive Summary); regardless of sex. Inasmuch as atherosclerotic vascular disease is frequently found in multiple vascular beds, the physician should search for symptoms or signs of peripheral vascular disease or cerebrovascular disease in patients presenting with STEMI.

Patient Education Before Discharge

Class I

1. Before hospital discharge, all STEMI patients should be educated about and actively involved in planning for adherence to the lifestyle changes and drug therapies that are important for the secondary prevention of cardiovascular disease. (Level of Evidence: B)
2. Post-STEMI patients and their family members should receive discharge instructions about recognizing acute cardiac symptoms and appropriate actions to take in response (i.e., calling 9-1-1 if symptoms are unimproved or worsening 5 minutes after onset, or if symptoms are unimproved or worsening 5 minutes after 1 sublingual nitroglycerin dose) to ensure early evaluation and treatment should symptoms recur. (Level of Evidence: C)
3. Family members of STEMI patients should be advised to learn about AEDs and CPR and be referred to a CPR training program. Ideally, such training programs would have a social support component targeting family members of high-risk patients. (Level of Evidence: C)

Lipid Management

Class I

1. Dietary therapy that is low in saturated fat and cholesterol (less than 7% of total calories as saturated fat and less than 200 mg/day cholesterol) should be started on discharge after recovery from STEMI. Increased consumption of the following should be encouraged: omega-3 fatty acids, fruits, vegetables, soluble (viscous) fiber, and whole grains. Calorie intake should be balanced with energy output to achieve and maintain a healthy weight. (Level of Evidence: A)
2. A lipid profile should be obtained from past records, but if not available, it should be performed in all patients with STEMI, preferably after they have fasted and within 24 hours of admission. (Level of Evidence: C)
3. The target low-density lipoprotein cholesterol (LDL-C) level after STEMI should be substantially less than 100 mg/dL. (Level of Evidence: A)
 - a. Patients with LDL-C 100 mg/dL or above should be prescribed drug therapy on hospital discharge, with preference given to statins. (Level of Evidence: A)
 - b. Patients with LDL-C less than 100 mg/dL or unknown LDL-C levels should be prescribed statin therapy on hospital discharge. (Level of Evidence: B)
4. Patients with non-high-density lipoprotein cholesterol (non HDL-C) levels less than 130 mg/dL who have an HDL-C level less than 40 mg/dL should receive special emphasis on nonpharmacological therapy (e.g., exercise, weight loss, and smoking cessation) to increase HDL-C. (Level of Evidence: B)

Class IIa

1. It is reasonable to prescribe drug therapy at discharge to patients with non-HDL-C greater than or equal to 130 mg/dL, with a goal of reducing non-HDL-C to substantially less than 130 mg/dL. (Level of Evidence: B)
2. It is reasonable to prescribe drug therapy such as niacin or fibrate therapy to raise HDL-C levels in patients with LDL-C less than 100 mg/dL and non-HDL-C less than 130 mg/dL but HDL-C less than 40 mg/dL despite dietary and other

- nonpharmacological therapy. (Level of Evidence: B) Dietary-supplement niacin must not be used as a substitute for prescription niacin, and over-the-counter niacin should be used only if approved and monitored by a physician.
3. It is reasonable to add drug therapy with either niacin or a fibrate to diet regardless of LDL-C and HDL-C levels when triglyceride levels are greater than 500 mg/dL. In this setting, non-HDL-C (goal substantially less than 130 mg/dL) should be the cholesterol target rather than LDL-C. (Level of Evidence: B) Dietary supplement niacin must not be used as a substitute for prescription niacin, and over-the-counter niacin should be used only if approved and monitored by a physician.

See Table 4 of the original guideline document's Executive Summary for additional discussion of recommendations.

Weight Management

Class I

1. Measurement of waist circumference and calculation of body mass index are recommended. Desirable body mass index range is 18.5 to 24.9 kg/m². A waist circumference greater than 40 inches in men and 35 inches in women would result in evaluation for metabolic syndrome and implementation of weight-reduction strategies. (Level of Evidence: B)
2. Patients should be advised about appropriate strategies for weight management and physical activity (usually accomplished in conjunction with cardiac rehabilitation). (Level of Evidence: B)
3. A plan should be established to monitor the response of body mass index and waist circumference to therapy (usually accomplished in conjunction with cardiac rehabilitation). (Level of Evidence: B)

Smoking Cessation

Class I

1. Patients recovering from STEMI who have a history of cigarette smoking should be strongly encouraged to stop smoking and to avoid secondhand smoke. Counseling should be provided to the patient and family, along with pharmacological therapy (including nicotine replacement and bupropion) and formal smoking-cessation programs as appropriate. (Level of Evidence: B)
2. All STEMI patients should be assessed for a history of cigarette smoking. (Level of Evidence: A)

Antiplatelet Therapy

Class I

1. A daily dose of aspirin 75 to 162 mg orally should be given indefinitely to patients recovering from STEMI. (Level of Evidence: A)
2. If true aspirin allergy is present, preferably clopidogrel (75 mg orally per day) or, alternatively, ticlopidine (250 mg orally twice daily) should be substituted. (Level of Evidence: C)

3. If true aspirin allergy is present, warfarin therapy with a target INR of 2.5 to 3.5 is a useful alternative to clopidogrel in patients less than 75 years of age who are at low risk for bleeding and who can be monitored adequately for dose adjustment to maintain a target INR range. (Level of Evidence: C)

Class III

1. Ibuprofen should not be used because it blocks the antiplatelet effects of aspirin. (Level of Evidence: C)

Inhibition of Renin-Angiotensin-Aldosterone-System

Class I

1. An ACE inhibitor should be prescribed at discharge for all patients without contraindications after STEMI. (Level of Evidence: A)
2. Long-term aldosterone blockade should be prescribed for post-STEMI patients without significant renal dysfunction (creatinine should be less than or equal to 2.5 mg/dL in men and less than or equal to 2.0 mg/dL in women) or hyperkalemia (potassium should be less than or equal to 5.0 mEq/L) who are already receiving therapeutic doses of an ACE inhibitor, have an LVEF less than or equal to 0.40, and have either symptomatic heart failure or diabetes. (Level of Evidence: A)
3. An ARB should be prescribed at discharge in those STEMI patients who are intolerant of an ACE inhibitor and have either clinical or radiological signs of heart failure and LVEF less than 0.40. Valsartan and candesartan have established efficacy for this recommendation. (Level of Evidence: B)

Class IIa

1. In STEMI patients who tolerate ACE inhibitors, an ARB can be useful as an alternative to ACE inhibitors in the long-term management of STEMI patients, provided there are either clinical or radiological signs of heart failure or LVEF less than 0.40. Valsartan and candesartan have established efficacy for this recommendation. (Level of Evidence: B)

Class IIb

1. The combination of an ACE inhibitor and an ARB may be considered in the long-term management of STEMI patients with persistent symptomatic heart failure and LVEF less than 0.40. (Level of Evidence: B)

Beta-Blockers

Class I

1. All patients after STEMI except those at low risk (normal or near-normal ventricular function, successful reperfusion, and absence of significant ventricular arrhythmias) and those with contraindications should receive beta-blocker therapy. Treatment should begin within a few days of the event, if not initiated acutely, and continue indefinitely. (Level of Evidence: A)

2. Patients with moderate or severe LV failure should receive beta-blocker therapy with a gradual titration scheme. (Level of Evidence: B)

Class IIa

1. It is reasonable to prescribe beta-blockers to low-risk patients after STEMI who have no contraindications to that class of medications. (Level of Evidence: A)

The use of beta-blockers in the early phase of STEMI and in hospital management is reviewed in Sections 6.3.1.6 and 7.4.1 of the full-text guidelines.

Blood Pressure Control

Class I

1. Blood pressure should be treated with drug therapy to a target level of less than 140/90 mm Hg and to less than 130/80 mm Hg for patients with diabetes or chronic kidney disease. (Level of Evidence: B)
2. Lifestyle modification (weight control, dietary changes, physical activity, and sodium restriction) should be initiated in all patients with blood pressure greater than or equal to 120/80 mm Hg. (Level of Evidence: B)

Class IIb

1. A target blood pressure goal of 120/80 mm Hg for post-STEMI patients may be reasonable. (Level of Evidence: C)

Class III

1. Short-acting dihydropyridine calcium channel blocking agents should not be used for the treatment of hypertension. (Level of Evidence: B)

Diabetes Management

Class I

1. Hypoglycemic therapy should be initiated to achieve HbA1c less than 7%. (Level of Evidence: B)

Class III

1. Thiazolidinediones should not be used in patients recovering from STEMI who have New York Heart Association class III or IV heart failure. (Level of Evidence: B)

Hormone Therapy

Class III

1. Hormone therapy with estrogen plus progestin should not be given de novo to postmenopausal women after STEMI for secondary prevention of coronary events. (Level of Evidence: A)
2. Postmenopausal women who are already taking estrogen plus progestin at the time of a STEMI should not continue hormone therapy. However, women who are beyond 1 to 2 years after initiation of hormone therapy who wish to continue hormone therapy for another compelling indication should weigh the risks and benefits, recognizing a greater risk of cardiovascular events. However, hormone therapy should not be continued while patients are on bed rest in the hospital. (Level of Evidence: B)

Warfarin Therapy

Class I

1. Warfarin should be given to aspirin-allergic post-STEMI patients with indications for anticoagulation as follows:
 - a. Without stent implanted (INR 2.5 to 3.5). (Level of Evidence: B)
 - b. With stent implanted and clopidogrel 75 mg/d administered concurrently (INR 2.0 to 3.0). (Level of Evidence: C)
2. Warfarin (INR 2.5 to 3.5) is a useful alternative to clopidogrel in aspirin-allergic patients after STEMI who do not have a stent implanted. (Level of Evidence: B)
3. Warfarin (INR 2.0 to 3.0) should be prescribed for post-STEMI patients with either persistent or paroxysmal atrial fibrillation. (Level of Evidence: A)
4. In post-STEMI patients with LV thrombus noted on an imaging study, warfarin should be prescribed for at least 3 months (Level of Evidence: B) and indefinitely in patients without an increased risk of bleeding. (Level of Evidence: C)
5. Warfarin alone (INR 2.5 to 3.5) or warfarin (INR 2.0 to 3.0) in combination with aspirin (75 to 162 mg) should be prescribed in post-STEMI patients who have no stent implanted and who have indications for anticoagulation. (Level of Evidence: B)

Class IIa

1. In post-STEMI patients less than 75 years of age without specific indications for anticoagulation who can have their level of anticoagulation monitored reliably, warfarin alone (INR 2.5 to 3.5) or warfarin (INR 2.0 to 3.0) in combination with aspirin (75 to 162 mg) can be useful for secondary prevention. (Level of Evidence: B)
2. It is reasonable to prescribe warfarin to post-STEMI patients with LV dysfunction and extensive regional wall-motion abnormalities. (Level of Evidence: A)

Class IIb

1. Warfarin may be considered in patients with severe LV dysfunction, with or without CHF. (Level of Evidence: C)

Refer to Figure 7 of the original guideline document's Executive Summary.

Physical Activity

Class I

1. On the basis of assessment of risk, ideally with an exercise test to guide the prescription, all patients recovering from STEMI should be encouraged to exercise for a minimum of 30 minutes, preferably daily but at least 3 or 4 times per week (walking, jogging, cycling, or other aerobic activity), supplemented by an increase in daily lifestyle activities (e.g., walking breaks at work, gardening, and household work). (Level of Evidence: B)
2. Cardiac rehabilitation/secondary prevention programs, when available, are recommended for patients with STEMI, particularly those with multiple modifiable risk factors and/or those moderate- to high-risk patients for whom supervised exercise training is warranted. (Level of Evidence: C)

Antioxidants

Class III

1. Antioxidant vitamins such as vitamin E and/or vitamin C supplements should not be prescribed to patients recovering from STEMI to prevent cardiovascular disease. (Level of Evidence: A)

Long Term Management

Psychosocial Impact of STEMI

Class I

1. The psychosocial status of the patient should be evaluated, including inquiries regarding symptoms of depression, anxiety, or sleep disorders and the social support environment. (Level of Evidence: C)

Class IIa

1. Treatment with cognitive-behavioral therapy and selective serotonin reuptake inhibitors can be useful for STEMI patients with depression that occurs in the year after hospital discharge. (Level of Evidence: A)

Cardiac Rehabilitation

Class I

1. Cardiac rehabilitation/secondary prevention programs, when available, are recommended for patients with STEMI, particularly those with multiple modifiable risk factors and/or those moderate- to high-risk patients for whom supervised exercise training is warranted. (Level of Evidence: C)

Follow-Up Visit with Medical Provider

Class I

1. A follow-up visit should delineate the presence or absence of cardiovascular symptoms and functional class. (Level of Evidence: C)
2. The patient's list of current medications should be reevaluated in a follow-up visit, and appropriate titration of ACE inhibitors, beta-blockers, and statins should be undertaken. (Level of Evidence: C)
3. The predischARGE risk assessment and planned workup should be reviewed and continued (Figure 6 in the original guideline document's Executive Summary). This should include a check of LV function and possibly Holter monitoring for those patients whose early post-STEMI ejection fraction was 0.31 to 0.40 or lower, in consideration of possible ICD use (see Figure 5 of the original guideline document's Executive Summary). (Level of Evidence: C)
4. The health care provider should review and emphasize the principles of secondary prevention with the patient and family members (see Table 4 of the original guideline document's Executive Summary). (Level of Evidence: C)
5. The psychosocial status of the patient should be evaluated in follow-up, including inquiries regarding symptoms of depression, anxiety, or sleep disorders and the social support environment. (Level of Evidence: C)
6. In a follow-up visit, the health care provider should discuss in detail issues of physical activity, return to work, resumption of sexual activity, and travel, including driving and flying. The metabolic equivalent values for various activities are provided as a resource in Table 34 of the full-text guideline. (Level of Evidence: C)
7. Patients and their families should be asked if they are interested in CPR training after the patient is discharged from the hospital. (Level of Evidence: C)
8. Providers should actively review the following issues with patients and their families:
 - a. The patient's heart attack risk. (Level of Evidence: C)
 - b. How to recognize symptoms of STEMI. (Level of Evidence: C)
 - c. The advisability of calling 9-1-1 if symptoms are unimproved or worsening after 5 minutes, despite feelings of uncertainty about the symptoms and fear of potential embarrassment. (Level of Evidence: C)
 - d. A plan for appropriate recognition and response to a potential acute cardiac event, including the phone number to access EMS, generally 9-1-1. (Level of Evidence: C)
9. Cardiac rehabilitation/secondary prevention programs, when available, are recommended for patients with STEMI, particularly those with multiple modifiable risk factors and/or those moderate- to high-risk patients in whom supervised exercise training is warranted. (Level of Evidence: C)

Definitions:

Classification of Recommendations

Class I: Conditions for which there is evidence and/or general agreement that a given procedure or treatment is beneficial, useful, and effective.

Class II: Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.

Class IIa: Weight of evidence/opinion is in favor of usefulness/efficacy.

Class IIb: Usefulness/efficacy is less well established by evidence/opinion.

Class III: Conditions for which there is evidence and/or general agreement that a procedure/treatment is not useful/effective and in some cases may be harmful.

Levels of Evidence

A: Data derived from multiple randomized clinical trials or meta-analyses

B: Data derived from a single randomized trial, or nonrandomized studies

C: Only consensus opinion of experts, case studies, or standard-of-care

CLINICAL ALGORITHM(S)

Clinical algorithms in the original guideline documents (Full-text and Executive Summary) are provided for:

1. The evaluation and management of patients suspected of having acute coronary syndrome
2. The management of patients with ischemic discomfort presenting with or without ST elevation
3. The management of potential patients with STEMI who are experiencing non-trauma-related chest pain/discomfort
4. Options for transportation of STEMI patients and initial reperfusion treatment
5. Reperfusion checklist for evaluation of patients with ST-elevation myocardial infarction (STEMI)
6. The diagnosis of recurrent myocardial infarction (MI) after the index STEMI event
7. Recommendations for initial reperfusion when cardiogenic shock complicates STEMI
8. Evaluation of intracranial hemorrhage complicating fibrinolytic therapy
9. Emergency management of complicated STEMI
10. Primary prevention of sudden death in post-STEMI patients without spontaneous ventricular fibrillation (VF) or sustained ventricular tachycardia (VT) at least 1 month post-STEMI
11. The management of recurrent ischemia/infarction after STEMI
12. The treatment of postreperfusion ischemic stroke
13. Determining need for catheterization and revascularization after STEMI
14. Management with long-term antithrombotic therapy at hospital discharge after STEMI

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The type of supporting evidence is identified and graded for each recommendation (see "Major Recommendations").

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

- Decreased morbidity and mortality due to ST-elevation myocardial infarction (STEMI)
- Effective secondary prevention of myocardial infarction and other cardiovascular events

Subgroups Most Likely to Benefit:

The reduction in mortality with fibrinolytic therapy is present regardless of sex, presence of diabetes, blood pressure (if less than 180 mm Hg systolic), heart rate, or history of previous myocardial infarction (MI). The mortality benefit is greater in the setting of anterior STEMI, diabetes, low blood pressure (less than 100 mm Hg systolic), or high heart rate (greater than 100 beats per minute). The earlier therapy begins, the better the outcome, with the greatest benefit decidedly occurring when therapy is given within the first 3 hours. Benefit occurs, however, up to at least 12 hours from the onset of symptoms. The absolute benefit is less with inferior STEMI, except for the subgroup with associated right ventricular infarction or anterior ST-segment depression indicative of a greater territory at risk.

POTENTIAL HARMS

Potential adverse effects associated with the major recommendations are discussed in greater detail in the guideline document and include the following:

- Thrombolytic therapy is associated with a slightly increased risk of intracranial hemorrhage (ICH) that usually occurs within the first day of therapy.
- Complications associated with invasive and surgical interventions (e.g., coronary artery bypass grafting [CABG]).

Subgroups Most Likely to be Harmed:

Risk of elective CABG after ST-elevation myocardial infarction (STEMI) is increased for patients with emergency or urgent surgery, older age, and poor ventricular function.

CONTRAINDICATIONS

CONTRAINDICATIONS

- Absolute contraindications to fibrinolysis in ST-elevation myocardial infarction (STEMI) include any prior intracranial hemorrhage, known structural cerebral vascular lesion (e.g., arteriovenous malformation), known malignant intracranial neoplasm (primary or metastatic), ischemic stroke within 3 months EXCEPT acute ischemic stroke within 3 hours, suspected aortic dissection, active bleeding or bleeding diathesis (excluding menses), significant closed-head or facial trauma within 3 months.

- Relative contraindications to fibrinolysis include history of chronic, severe, poorly controlled hypertension; severe uncontrolled hypertension on presentation (systolic blood pressure greater than 180 mm Hg or diastolic blood pressure greater than 110 mm Hg) (could be absolute contraindication in low-risk patients); history of prior ischemic stroke greater than 3 months, dementia, or known intracranial pathology not covered in contraindications; traumatic or prolonged (greater than 10 minutes) cardiopulmonary resuscitation or major surgery (less than 3 weeks); recent (within 2 to 4 weeks) internal bleeding; noncompressible vascular punctures; for streptokinase/anistreplase, prior exposure (more than 5 days ago) or prior allergic reaction to these agents; pregnancy; active peptic ulcer; current use of anticoagulants: the higher the international normalized ratio (INR), the higher the risk of bleeding.
- Aspirin is contraindicated in those with a hypersensitivity to salicylates.
- The following are relative contraindications to beta-blocker therapy: heart rate less than 60 bpm, systolic arterial pressure less than 100 mm Hg, moderate or severe left ventricular failure, signs of peripheral hypoperfusion, shock, PR interval greater than 0.24 second, second- or third-degree atrioventricular (AV) block, active asthma, or reactive airway disease. tachyarrhythmias.
- Metformin is contraindicated in the presence of congestive heart failure and renal failure. It should be withheld for 48 hours after intravenous contrast injection
- Diltiazem and verapamil are contraindicated in patients with STEMI and associated systolic left ventricular dysfunction and congestive heart failure.
- Nifedipine (immediate-release form) is contraindicated in the treatment of STEMI because of the reflex sympathetic activation, tachycardia, and hypotension associated with its use.
- Angiotensin-converting enzyme (ACE) inhibitors should not be used if systolic blood pressure is less than 100 mm Hg or less than 30 mm Hg below baseline, if clinically relevant renal failure is present, if there is a history of bilateral stenosis of the renal arteries, or if there is known allergy to ACE inhibitors.

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

- These practice guidelines are intended to assist healthcare providers in clinical decision making by describing a range of generally acceptable approaches for the diagnosis, management, and prevention of specific diseases or conditions. These guidelines attempt to define practices that meet the needs of most patients in most circumstances. These guideline recommendations reflect a consensus of expert opinion after a thorough review of the available, current scientific evidence and are intended to improve patient care. If these guidelines are used as the basis for regulatory/payer decisions, the ultimate goal is quality of care and serving the patient's best interests. The ultimate judgment regarding care of a particular patient must be made by the healthcare provider and patient in light of all of the circumstances presented by that patient. There are circumstances where deviations from these guidelines are appropriate.

- Although these guidelines on ST-elevation myocardial infarction (STEMI) have been shaped largely within the context of evidence-based medical practice, the guideline committee clearly understands that variations in inclusion and exclusion criteria from one randomized trial to another impose some limitation on the generalizability of their findings. Likewise, in its efforts to reconcile conflicting data, the committee emphasized the importance of properly characterizing the population under study.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

A pocket guide for health care professionals provides rapid prompts for appropriate patient management, which is outlined in much greater detail in the full-text guidelines. The full text of the guidelines is available on the World Wide Web sites of the American College of Cardiology (www.acc.org) and the American Heart Association (www.americanheart.org). The executive summary is published in the August 4, 2004 issue of the Journal of the American College of Cardiology and the August 3, 2004 issue of Circulation.

Critical pathways and protocols and other quality improvement tools (e.g., the American College of Cardiology "Guidelines Applied in Practice" and the American Heart Association's "Get with the Guidelines") should be used to improve the application of evidence-based treatments by patients with ST-elevation myocardial infarction, caregivers, and institutions.

IMPLEMENTATION TOOLS

Clinical Algorithm
Pocket Guide/Reference Cards

For information about [availability](#), see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better
Living with Illness

IOM DOMAIN

Effectiveness
Patient-centeredness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, Hochman JS, Krumholz HM, Kushner FG, Lamas GA, Mullany CJ, Ornato JP, Pearle DL, Sloan MA, Smith SC Jr. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction. A report of the Am Coll of Cardiol/American Heart Association Task Force on Practice Guidelines (Committee to revise the 1999 guidelines). Bethesda (MD): American College of Cardiology, American Heart Association; 2004. 211 p. [1398 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1996 Nov 1 (revised 2004 Jul)

GUIDELINE DEVELOPER(S)

American College of Cardiology Foundation - Medical Specialty Society
American Heart Association - Professional Association

GUIDELINE DEVELOPER COMMENT

In collaboration with the Canadian Cardiovascular Society

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The American College of Cardiology Foundation and the American Heart Association. No outside funding accepted.

GUIDELINE COMMITTEE

American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines for the Management of Patients With Acute Myocardial Infarction)

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Committee members were selected from cardiovascular specialists with broad geographical representation and combined involvement in academic medicine and primary practice. The Committee on Management of Acute Myocardial Infarction was also broadened by members of the American Academy of Family Physicians, the American College of Emergency Physicians, the AHA Council on Cardiovascular Nursing, and the American Association of Critical-Care Nurses.

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FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

The American College of Cardiology/American Heart Association (ACC/AHA) Task Force on Practice Guidelines makes every effort to avoid any actual or potential conflicts of interest that might arise as a result of an outside relationship or personal interest of a member of the writing panel. Specifically, all members of the writing panel are asked to provide disclosure statements of all such relationships that might be perceived as real or potential conflicts of interest. These statements are reviewed by the parent task force, reported orally to all members of the writing panel at each meeting, and updated and reviewed by the writing committee as changes occur.

Relationships with industry of committee members and external peer reviewers, including research grants, speakers bureau/honoraria, stock ownership, and consultancies/advisory board memberships, are provided in Appendices 1 and 2 of the original full-text guideline document.

ENDORSER(S)

Canadian Cardiovascular Society

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Ryan TJ, Antman EM, Brooks NH, Califf RM, Hillis LD, Hiratzka LF, Rapaport E, Riegel B, Russell RO, Smith EE III, Weaver WD. 1999 update: ACC/AHA guidelines for the management of patients with acute myocardial infarction. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 1999 Sep;34(3):890-911.

GUIDELINE AVAILABILITY

Electronic copies: Available from the [American College of Cardiology \(ACC\) Web site](#) and from the [American Heart Association \(AHA\) Web site](#).

Print copies: Available from the ACC, Resource Center, 9111 Old Georgetown Rd, Bethesda, MD 20814-1699; (800) 253-4636 (US only).

AVAILABILITY OF COMPANION DOCUMENTS

The following are available:

- 2004 update: ACC/AHA guidelines for the management of patients with acute myocardial infarction: executive summary and recommendations: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1999 Guidelines for the Management of Patients With Acute Myocardial Infarction).

Electronic copies: Available from the [American College of Cardiology \(ACC\) Web site](#).

- ACC/AHA pocket guidelines for the management of patients with acute myocardial infarction.

Electronic copies: Available in PDF from the [American College of Cardiology \(ACC\) Web site](#).

Print copies: Available from ACC, Resource Center, 9111 Old Georgetown Rd, Bethesda, MD 20814-1699; (800) 253-4636 (US only).

PATIENT RESOURCES

None available

NGC STATUS

The original NGC summary was completed by ECRI on June 30, 1998. The summary was updated by ECRI on September 2, 1999. This updated information was verified by the guideline developer on October 8, 1999. This summary was updated most recently on September 10, 2004. The updated information was verified by the guideline developer on February 23, 2005. This summary was updated on May 3, 2005 following the withdrawal of Bextra (valdecoxib) from the market and the release of heightened warnings for Celebrex (celecoxib) and other nonselective nonsteroidal anti-inflammatory drugs (NSAIDs). This summary was updated by ECRI on June 16, 2005, following the U.S. Food and Drug Administration advisory on COX-2 selective and non-selective non-steroidal anti-inflammatory drugs (NSAIDs).

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